Tau

User's Manual

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If you have questions that are not covered in this manual, or need service, contact FLIR CVS Customer Support at 805.964.9797 for additional information prior to returning a camera.

This documentation is subject to change without notice.

Table of Contents

1 Introduction

The Tau is a long-wavelength (8 – 14 microns) uncooled microbolometer camera designed for infrared imaging applications that demand absolute minimum size, weight, and power consumption. It is available with multiple different lens focal length options, as well as a No Lens option intended for customers who mount their own lens and perform ancillary Alternate Lens Calibration—See “Software accessory SDK for Windows & Embedded” on page 2-3.

5 mm (43° HFOV) | **9 mm (48° HFOV)** | **13 mm (34° HFOV)** | **19 mm (24° HFOV)**

Figure 1-1: Tau Cameras

The camera provides “power-in, video-out” capability, which means that one need only apply input voltage to receive analog video. For those applications demanding more advanced control, the Tau camera includes a serial interface (RS-232) for transmitting camera commands and receiving status. In more demanding situations, the Tau camera also provides 14-bit and 8-bit digital video options, including CMOS, BT-656, and the Legacy Photon LVDS—See “Tau Digital Data Channel” on page 4-1.

1.1 Tau Specifications

- 320 (H) x 256 (V) or 160 (H) x 120 (V) uncooled microbolometer sensor array, 25 x 25 micron pixels
- Spectral band: 7.5 - 13.5µm
- NEdT Performance: < 50mK at f/1.0[1]
- Input voltage range: 4.0 – 6.0 VDC
- Power Consumption: < 1.0 Watts (nominal at room temperature using 5V input)
- Time to image: ~ 2 seconds
- Operating Temperature Range: -40°C to +80°C
- Weight: 70 grams with either the 5, 9, 13, or 19mm lens option

Note

The Tau camera is an export controlled item. In order to increase the Camera's exportability, a 'Slow Video' version of Tau is available. The frame rate is reduced to approximately 9 Hz. This change allows Tau to be exported without US export license to most countries. Please contact FLIR Inc. for additional information.

- Analog video output:

  NTSC (320x240) 30Hz (slow video output rate (7.5Hz) is available for exportability)
  or
  PAL (320x256) 25Hz (slow video output rate (8.3Hz) is available for exportability)

Note

The NTSC analog video format is the default in all cameras. The FLIR Camera Controller software allows you to select between NTSC or PAL video output formats and save this setting.

- Digital video output: 8- or 14-bit serial LVDS, CMOS, BT 656
- Remote camera control RS-232 interface: FLIR Camera Controller software available for free download at www.corebyindigo.com/service/softwareupdates.cfm)
- 2X Digital Zoom with electronic pan/tilt
- Dynamic Digital Detail Enhancement (DDE)

Note: These specifications are subject to change without notice.

The latest information concerning specifications, accessories, camera configurations, and other information can be found in the Tau Thermal Imaging Camera Core Data Sheet at: http://www.corebyindigo.com/products/uncooledcores.cfm.

1. NEdT at the camera output measured with FLIR's proprietary noise reduction applied in the as-shipped configuration. Typical performance is approximately 35mK with f/1.0 optics.

1.2 Available Tau Configurations

The Tau is available with different lenses providing different fields of view and the 'Slow Video' or '9 Hz' option for license-free exportability.

Note

Contact FLIR CVS Customer Support or your local FLIR sales representative for information on available Tau camera configurations, part numbers, and ordering information.

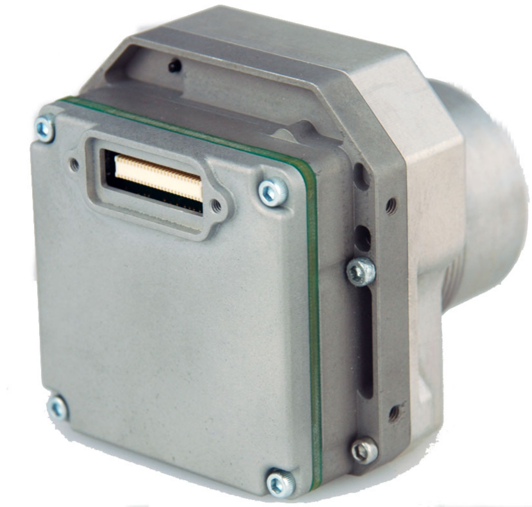


Figure 1-2: Tau Camera as delivered showing 50-pin Hirose Connector and Back Cover

1.3 Unpacking Your Tau Camera

The Tau camera is typically delivered as a standalone product; no documentation is included. Documentation and utilities such as the latest version of this User's Manual, the FLIR Camera Controller, and Mechanical Interface Description Documents are available for download from the www.corebyindigo.com website.

Please unpack the camera heeding customary Electrostatic Sensitive Device (ESD) precautions including static safe work station and proper grounding. The Tau camera is packaged in foam to prevent damage during shipping. It is also placed in a conductive anti-static bag to protect from electrostatic discharge damage.

Caution!

Disassembling the camera can cause permanent damage and will void the warranty.

Operating the camera outside of the specified input voltage range or the specified operating temperature range can cause permanent damage.

The camera is not sealed. Avoid exposure to dust and moisture.

This camera contains electrostatic discharge sensitive electronics and should be handled appropriately.

2.1 Tau Video Power Com (VPC) Accessory

The Tau VPC module is the first thing many users will connect their Tau camera, and for some customers it may be the only thing they will ever need. The VPC provides connection to a host computer for power, command/control, and digital image capture; it has a direct connection for analog image output.

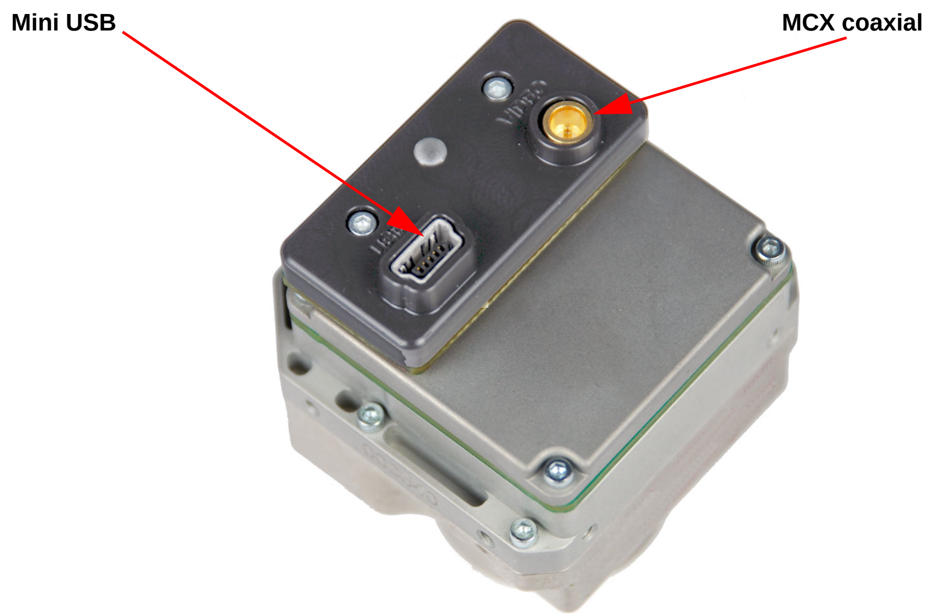


Figure 2-1: Tau VPC module with Tau camera

- Connector Type: USB mini 5-pin
- Power over USB: nominal draw 180mA at 5V
  (peak load at startup 500mA at 5V)
- Command communications Rate: 57600 Baud
- Hot swap protected
- Windows Service for automatic detector supported through SDK

Table 2-1: Miniplug / Microplug

Pin	Name	Color	Description
1	VCC	Red	+5 V
2	D-	White	Data -
3	D+	Green	Data +
4	ID[1]	none	permits distinction of Micro-A- and Micro-B-Plug Type A: connected to Ground, Type B: not connected
5	GND	Black	Signal Ground

1. Pin 4 of mini-USB connector may be not connected, connected to GND, or used as attachment identification at some portable devices.

2.2 Backward-compatible Photon accessories

The following are accessories that offer a development environment or extended features for your Tau camera.

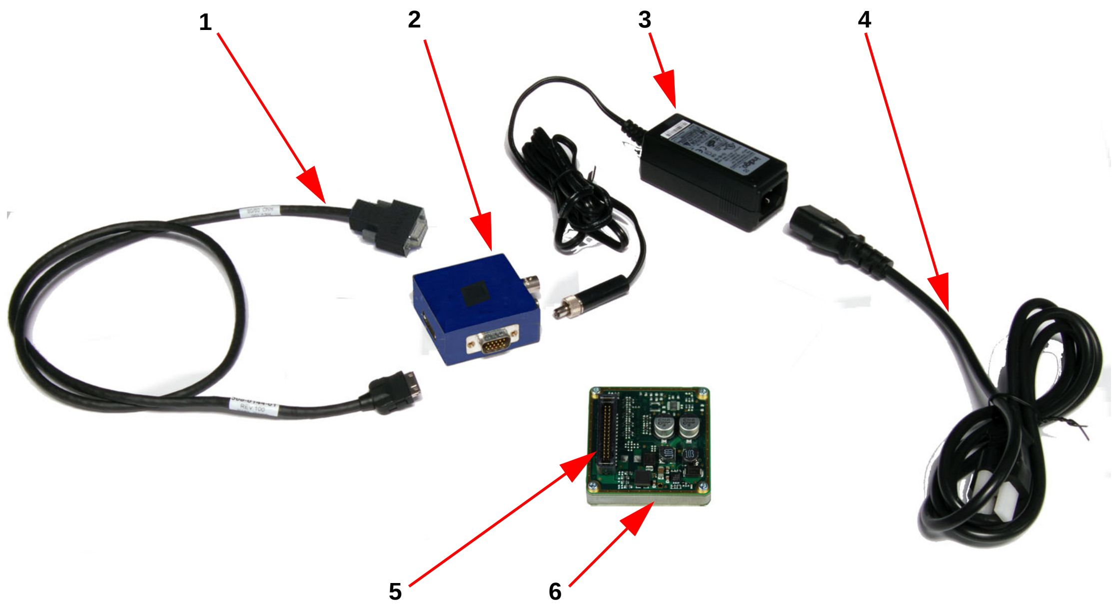


Figure 2-2: Photon Replicator Kit

1. Cable, Tau to I/O Module, 6 foot length
   (Part Number: 308-0076-02)
2. Input/Output (I/O) Module (Part Number: 333-0018-00)
3. AC/DC Power Supply (Part Number: 206-0001-20)[1]
4. IEC Line Cord (Part Number: 208-0004-02)
5. Photon Replicator Board (Part Number: 250-0324-00)
6. Board Spacer (Part Number: 261-1477-00)
7. Wearsaver (Part Number: 250-0194-00) Not Shown

The Photon Replicator kit includes a power supply, input/output module (interconnect box), Photon Replicator Board (26-pin to 50-pin adapter to Tau allowing use of existing Photon cables and accessories), and cables to facilitate AC power in and analog video out for your Tau camera. With this accessory kit, the customer only needs to purchase a standard RS-232 COM cable in order to perform advanced configuration using the free downloadable FLIR Camera Controller. Longer screws are required to mount the replicator board to the Tau core.

1. Photon Replicator Board accepts 6-24V. (The Tau core input voltage is 4-6V without the replicator attached.)

Figure 2-3: Digital Data Serial-to-Parallel Module or SIPO (Part Number: 333-0017-00)

FLIR's optional serial-in, parallel-out (SIPO) module converts the serial LVDS into parallel data. The SIPO mates directly to the I/O module's digital data port, and furnishes a 68-pin connector that can be attached to a frame grabber via a digital interface cable. This accessory facilitates capture of the LVDS serial digital data channel from the Tau camera and mirrors it in a parallel format used with computer-based capture boards.

These boards require third-party software not offered or formally supported by FLIR. Refer to Chapter 4 for details on known compatible frame grabbers and interface cables, as well as setup files for the two we have verified.

2.3 Software accessory SDK for Windows & Embedded

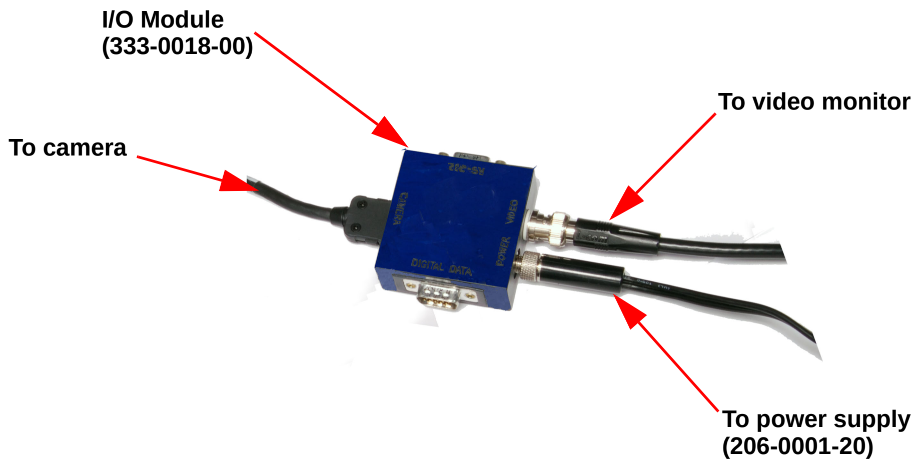
The Tau Software Developer's Kit (SDK Part Number 110-0102-46) enables camera control using one of several programming languages including VB6, VB.net, C#, and C++ (MFC). Code examples are included to help illustrate how some of the camera control functions can be used. The FLIR Camera Controller is an example of an application created using the Photon SDK.
Refer to http://www.corebyindigo.com/service/softwareupdates.cfm.

3.1 Operation of the Tau camera using the Photon development kit

Backward compatibility with existing Photon equipment may be the simplest way to connect to your Tau camera to provide power and obtain video. It also facilitates serial communication for more advanced camera command and control via the free downloadable FLIR Camera Controller. In this first section, we will discuss simply applying power and obtaining video output, not serial communication.

Remove the lens cap. (Remember to replace the lens cap when the camera is not in use to prevent accidental scratching and dust contamination.)

Using the Development Kit's Interface Cable and I/O Module, plug one end of the Interface Cable into the mating connector on the back of the camera. Connect the other end of the Interface Cable to the mating connector on the I/O Module labeled **CAMERA**.



Attach one end of a standard BNC cable to the video port labeled **VIDEO** on the I/O Module. Attach the other end to a compatible video monitor's composite video input. If your monitor has an RCA input connector, a BNC to RCA adapter can be used.

Plug the power supply into an electrical outlet. Insert the circular plug at the other end of the power supply into the power jack labeled **POWER** on the I/O Module and tighten the locking screw finger tight. The camera will take ~2 seconds to produce an image after you apply of power.

You should see an initial splash screen with the FLIR logo displayed, and then live infrared long wave imaging video will follow! Point the camera in different directions and notice the imagery. If the video image appears low in contrast, point the camera at a scene with high thermal contrast such as at a person.

3.2 Remote control of the Tau camera

The Tau camera accommodates advanced camera control through an RS-232 serial interface. A user can control the camera via this interface by following the Serial Protocol Communication and command structure requirements located in Appendix B and their own hardware/software interface. This requires programming skills and a strong technical background. The user can also use the FLIR Camera Controller offered as a free download from FLIR using a Windows based PC with the standard serial communications and components provided in the Development Kit. This software provides remote control of various camera features and modes. The FLIR Camera Controller software is compatible with Windows XP. The PC must have a spare serial communications port or you must use the Tau VPC module USB accessory.

Note

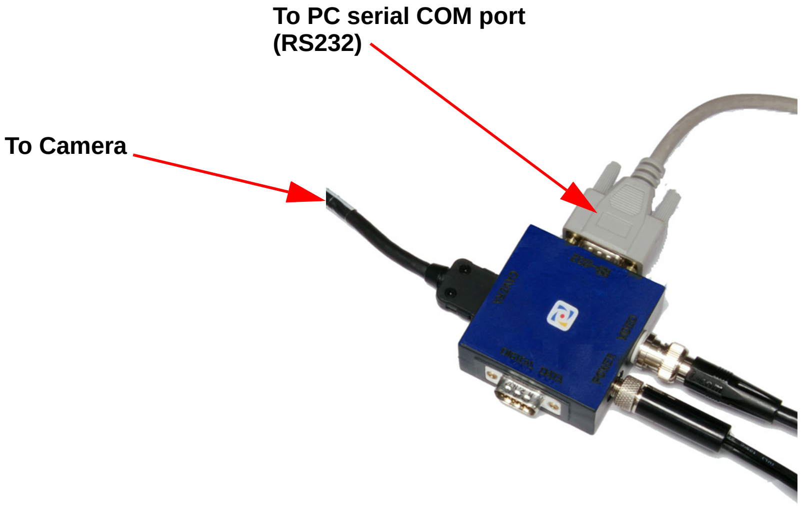
A USB to Serial port adapter is acceptable, but the data communication rate must be set to 57600 BAUD.

If your embedded or specialty applications require custom control software, a Software Developer's Kit (SDK) is available. Those intending to generate their own custom software are encouraged to read the remainder of this section regarding the FLIR Camera Controller to better understand the camera modes and parameters.

3.3 Connecting the serial communications interface using the development kit

You should have successfully operated the camera and obtained live video on a monitor as described in paragraph 3.1 "Operation of the Tau camera using the Photon development kit" on page 3-1.

The only additional hardware required for serial communication is a serial cable connected as shown below.



Attach one end of a standard RS-232 serial port (9-pin) PC cable to the communications port labeled **RS-232** on the I/O Module. Attach the other end to the serial port on your PC. This cable should be a standard RS-232 cable, not a cross-over configured serial cable.

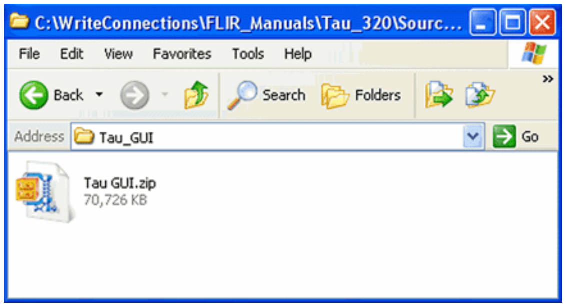
3.4 Installing the FLIR Camera Controller

Step 1 If you have another version of the FLIR Camera Controller loaded on your PC, you should uninstall it using the Windows Uninstall utility via the Windows Control Panel before proceeding with this installation. This is an important step as camera malfunction is possible if you do not remove any older versions of Tau (or Omega/Micron/A10) software.

Step 2 Using your favorite WWW browser, navigate to the following URL: http://www.corebyindigo.com/service/softwareupdates.cfm

Step 3 Click the **Download** FLIR Camera Controller link for the version which supports your Tau.

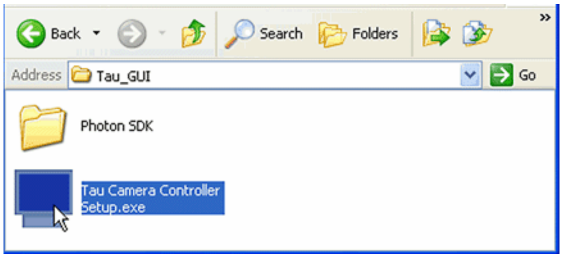
Step 4 When the **File Download** prompt appears, choose **Save**. This will save the installable file in the directory of your choice. It is recommended that you create a new empty directory such as "FLIR Camera Controller Installable Files" on your desktop, for download. The file *Tau_GUI.zip* will be saved.



Step 5 Open the directory where you saved the zip.

Step 6 Double click the Tua_GUI.zip file. The WinZip utility should open the zip file and show the compressed contents.

Step 7 Save the files shown via the WinZip **Extract** command. This method is important as it preserves the necessary installation paths for the install utility. It is not recommended that you drag-and-drop the contents from the WinZip utility. Extract to a directory of your choice.



Step 8 Navigate to the directory where you extracted the contents. Inside that folder you will find a directory which should contain the files shown: Double click the **FLIR Camera Controller setup.exe** file to begin installation.

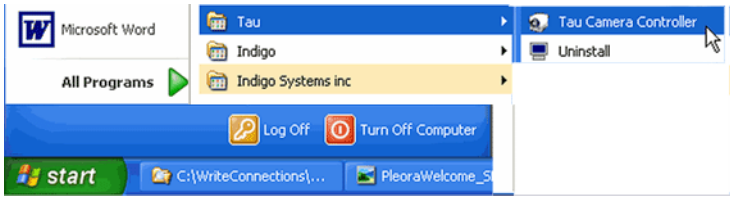
Step 9 Click **Next>>** at the Setup Welcome screen.
When the installer finishes loading. Follow the prompts.

Step 10 Select Destination Folder if different than the default. Then, click **Install**.

Step 11

Step 12 Once installation is complete, click **Finish**.

Step 13 Installation is complete. You can start the application or create a shortcut to the application via the
Start→Programs→Tau→FLIR Camera Controller path.



3.5 Connecting the Tau to a PC via the I/O Module

Step 1 Follow the steps shown in paragraph 3.1 "Operation of the Tau camera using the Photon development kit" on page 3-1 for basic operation of the camera. Power-down after verifying that the camera is producing an image.

Step 2 You may have done this operation in paragraph 3.1. If not, connect one end of a standard serial cable (user must provide as this is not included with the Tau camera or the Development Kit) to the 9-pin female DB9 connector on the I/O module labeled 'RS-232'. Do not use a 'cross-over' serial cable.

Step 3 Connect the other end of the standard serial cable to an unused serial port on your computer. These ports may be labeled 'COM1' or 'COM2'.

Step 4 Power on the camera. Assuming the FLIR Camera Controller software is already installed on the PC (see installation instructions above), launch the software by selecting **Start→Programs→Tau→FLIR Camera Controller**.

Note

The FLIR Camera Controller remembers the last COM port that successfully communicated with a Tau camera and will use that port as the default at start of the application. If the connected camera is no longer on that port, the port setting pop-up window will appear asking for you to select the proper port setting.

When the FLIR Camera Controller is started, the Status tab of the utility should return data similar to the following.

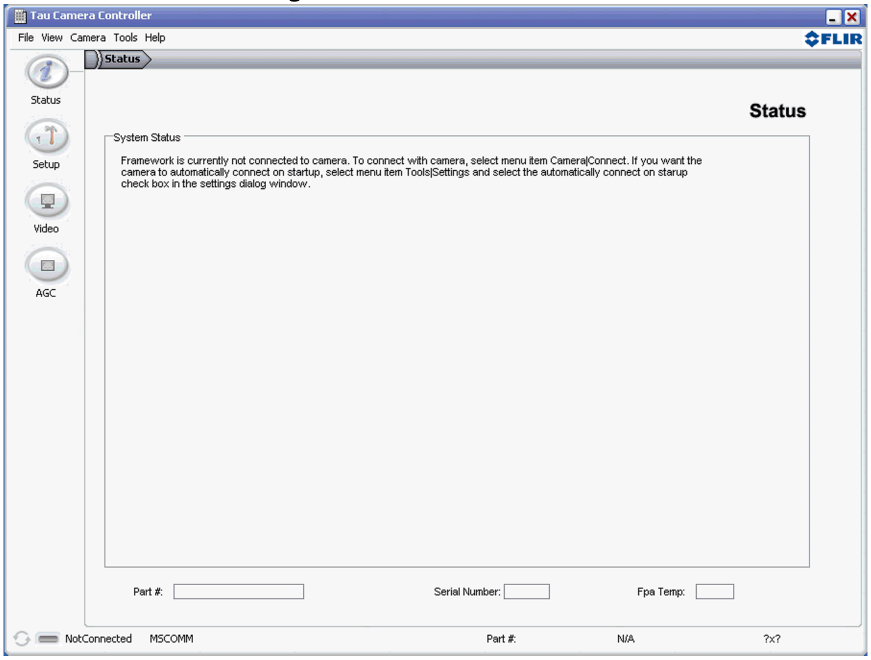
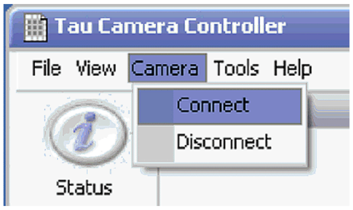


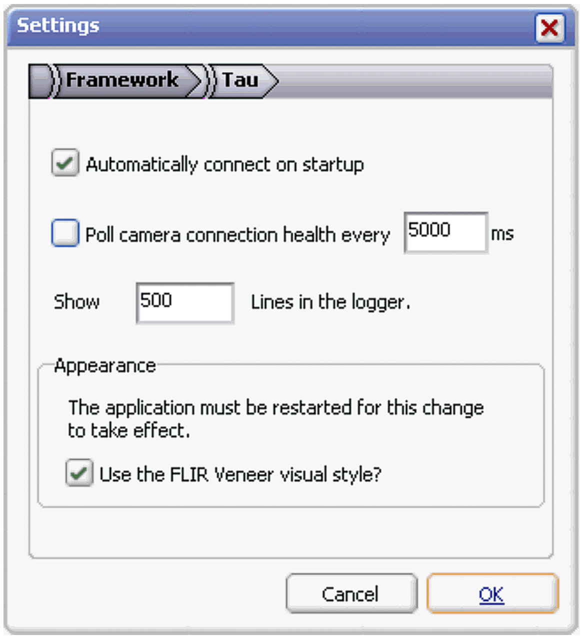
Figure 3-1: FLIR Camera Controller Status Tab

Step 5 Connect to your camera by selecting **Connect** from the **Camera** menu.



Step 6 If you want the FLIR Camera Controller to automatically connect when it is started, select **Settings** from the **Tools** menu, then check the **Automatically connect on startup** box in the **Settings Framework** tab.

Additional settings include camera connection polling, status logging, and FLIR Veneer style.



3.6 Troubleshooting the FLIR Camera Controller

If the FLIR Camera Controller does not link with the camera, you may see the popup shown at the right which indicates that the GUI has not been able to communicate with the Tau Camera.

Verify the items in the following checklist:

Is the camera properly cabled to the host PC? Verify that you selected the proper port if it was not detected automatically. Clicking in the lower right of the FLIR Camera Controller window on top of the word COM will bring up a dialog box indicating COM port. Also, try disconnecting and then re-connecting the RS-232 serial cable to the PC. If the GUI was launched before the serial cable was connected, close the GUI, connect the serial cable, then re-launch the GUI.

Is the port already in use by another application? Shut down any other applications that may be using the port. Also, multiple instances of the FLIR Camera Controller Program can be instantiated using different ports so be sure the camera you are interested in controlling is actually connected to the physical port.

Is the Tau camera power on? Verify that the camera is producing an image on a separate monitor. Also, at camera power up, you can hear two sets of a click-click sound, separated by about 5 seconds, as the internal shutter performs its on-power-up calibration. If you don't hear these sounds, it's likely the Tau camera is not being powered correctly.

If you cannot initiate serial communication with the camera after verifying these items, refer to the frequently asked questions (FAQ) at http://www.corebyindigo.com/Tau/TauFAQs_All.cfm or contact FLIR Customer Support at (805) 964-9797.

3.7 Operation of the FLIR Camera Controller

When the FLIR Camera Controller successfully links to the camera, you will see the window shown below. At the bottom of the application window, you should see Camera and FPA status. The GUI provides five tabs allowing for camera control as described below.

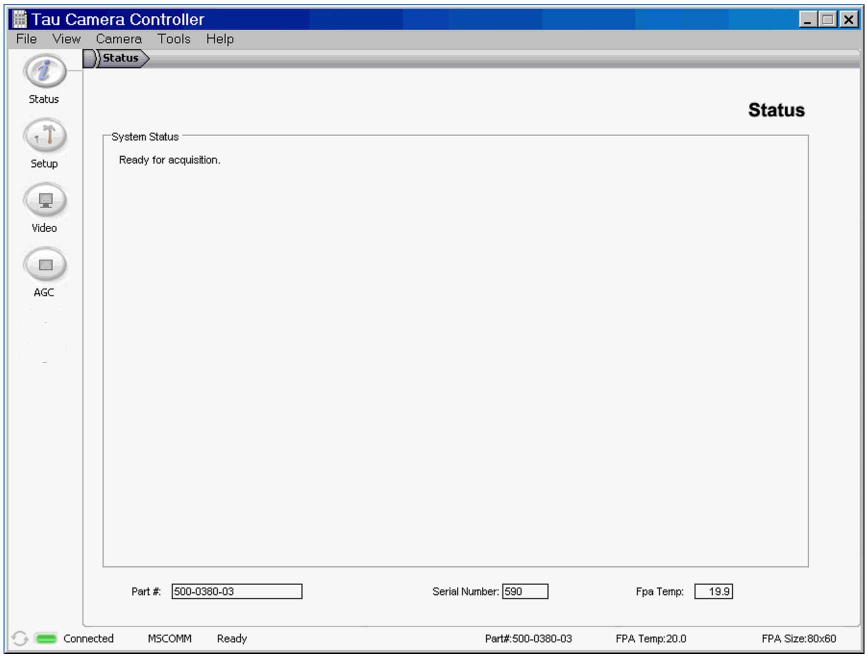


Figure 3-2: FLIR Camera Controller Status Tab

Camera Part #: indicates the specific camera configuration connected.

Camera Serial #: This is the serial number of the camera currently connected to the FLIR Camera Controller.

FPA Temperature: The camera's Focal Plane Array (FPA) temperature.

The connection status, Camera status, Camera Part #, FPA Temp, and FPA Size are displayed at the bottom of all tabs.

3.8 Setup Tab

The **Setup** tab, shown below, provides the ability to do the following:

- Modify the Flat Field Correction (FFC)
- Set the External Sync mode
- Freeze the video via the Operating Mode section
- Supplemental Offset
- Set the camera to generate a Test Pattern
- Save the settings to the camera's non volatile memory
- Restore the Factory Defaults
- Reset the Camera

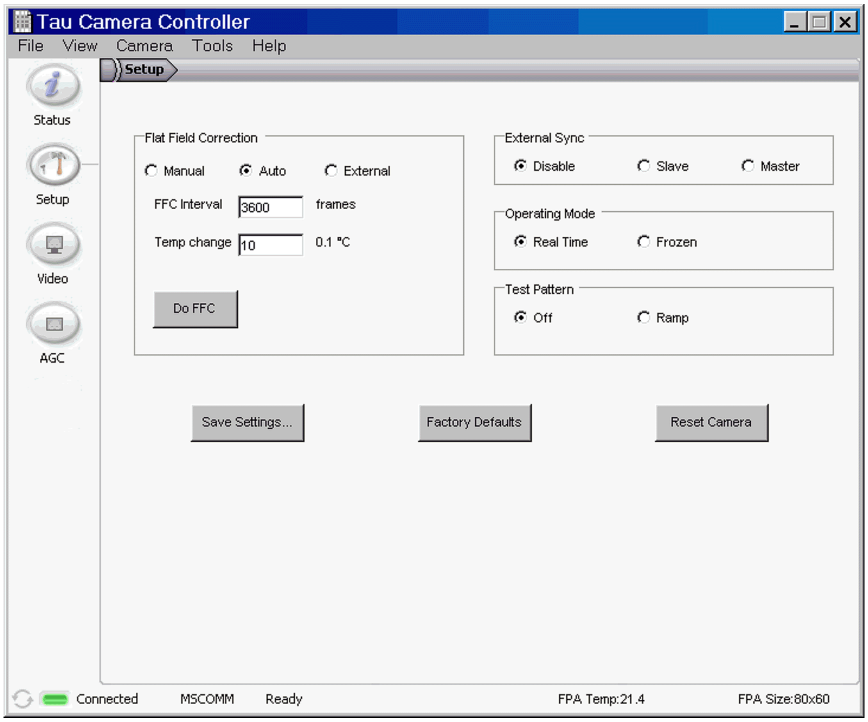
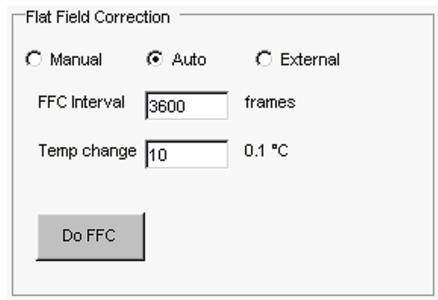


Figure 3-3: FLIR Camera Controller Setup Tab



Flat-Field-Correction Mode: Tau includes internal mechanisms for periodically improving image quality via a process called flat-field correction (FFC). During FFC, a small calibration flag (a shutter) rotates in front of the detector array, presenting a uniform temperature (a flat field) to every detector element. While imaging the flat field, the camera updates correction coefficients, resulting in a more uniform array output. The video image is frozen during the entire process, which takes less than a second, and it resumes automatically thereafter. Repeating the FFC operation often prevents the imagery from appearing "grainy". This is especially important when the camera temperature is fluctuating, such as immediately after turn-on or when ambient temperature is drifting. FFC can be controlled manually at any time using the **Do FFC** command button.

Tau provides three FFC modes:

> **Automatic**: In the Automatic FFC mode, the camera performs FFC whenever its temperature changes by a specified amount or at the end of a specified period of time (whichever comes first). When this mode is selected, input windows are available in the FLIR Camera Controller for specifying the temperature change and the number of frames that trigger automatic FFC. The temperature change is specified in degrees, with valid values in the range 0 to 100 in 0.1 degree increments. The time period is specified in analog video frames (33ms NTSC, 40ms PAL), with valid values in the range 0 to 30,000 frames.

Note

FLIR recommends using the factory default values for the two automatic-FFC parameters if possible. These values were selected to maintain a high degree of image quality over all camera operating conditions.

> **Manual**: In Manual FFC mode, the camera does not perform FFC automatically based on specified values of temperature change or expired time. The FFC will be performed using the internal shutter when the "Do FFC" button is clicked.

Note

Large camera temperature excursions cause the camera to perform the FFC operation (even with Manual FFC mode selected), typically at temperature crossings near 0°C and 40 °C.

> **External:** In External FFC mode a uniform source (blackbody) must be placed in front of the camera. The image of this uniform source will be subtracted from all subsequent images. This feature is useful if there are lens or lens mount non-uniformities that are not corrected by an internal FFC.

Tau displays an on-screen symbol called the Flat Field Imminent Symbol prior to performing an automatic FFC operation. As shown in Figure 3-4, it is the green square in the upper left of the video output and is displayed nominally 2 seconds prior to the FFC operation. The duration of the FFC Imminent Symbol can be set using the **FFC Warn Time** setting in the **Analog Video** tab. Setting the **Warn Time** to zero turns off the warning (see paragraph 3.9).

Figure 3-4: Flat Field Imminent Symbol

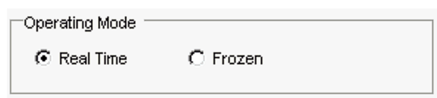
External Sync Mode: The Tau camera provides the ability to either accept or output a frame synchronization signal. This functionality can also be disabled.

Disabled: The camera will turn off frame synchronization.

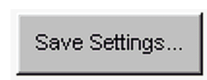
Slave: The camera will accept a frame synchronization signal on the interface connector. The camera output will be frozen if the camera is in slave mode and no external synchronization signal is received.

Master: The camera will output a frame synchronization signal on the interface connector when configured as a master.

Operating Mode: The Tau camera will freeze the frame imaged when **Frozen** is selected. Live video will cease and the frozen frame will persist. To return the camera to live video, select **Real-Time** video mode.



Save Settings: After using the FLIR Camera Controller to change camera modes and settings to your desired values, use the **Save Settings** button to store your current selections as *new* power-up defaults. The next time the camera is powered, the Tau camera will remember these saved settings. If you do not click **Save Settings**, the changes you make via the FLIR Camera Controller will be valid only for the current session. Cycling power to the camera will revert to the previously saved settings.

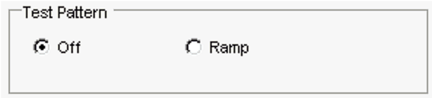


Factory Defaults: The **Factory Defaults** button restores the camera's settings to the initial values specified by the manufacturer.

If you want the factory default settings to become the power up defaults, first click the **Factory Defaults** button, then click the **Save Settings** button.

Reset Camera: The **Reset Camera** button restarts the camera software and is nearly identical to cycling power.

Test-Pattern: A Test-Pattern mode is provided to verify camera electronics.



Off: No test-pattern is provided in this mode. This is the normal mode for viewing thermal imagery.

Ramp: In this ramp mode, the test pattern shown below and in the Color/LUT section that follows is provided at the analog and digital data channels.

Figure 3-5: Ramp test pattern example for Top Portion of Tau Ramp Image
(Digital values shown apply to the optional 14-bit digital data stream.)

The above ramp pattern repeats 19 times in the complete 320 x 256 image.

Note

The ramp test pattern is intended primarily for verifying the output of the digital data channel. The pattern will not necessarily look as shown above when displayed on an analog video monitor, particularly if an Automatic Gain Control (AGC) mode other than Automatic is selected. The above image is a horizontal slice of the full displayed image.

3.9 Analog Video Tab

The **Analog Video** tab on the FLIR Camera Controller, shown below, provides the ability to modify four different Tau modes:

- Image Orientation
- Pan & Zoom
- Polarity/LUT
- FFC Warn Time
- Dynamic Digital Detail Enhancement (DDE)
- Video Color
- Video On/Off

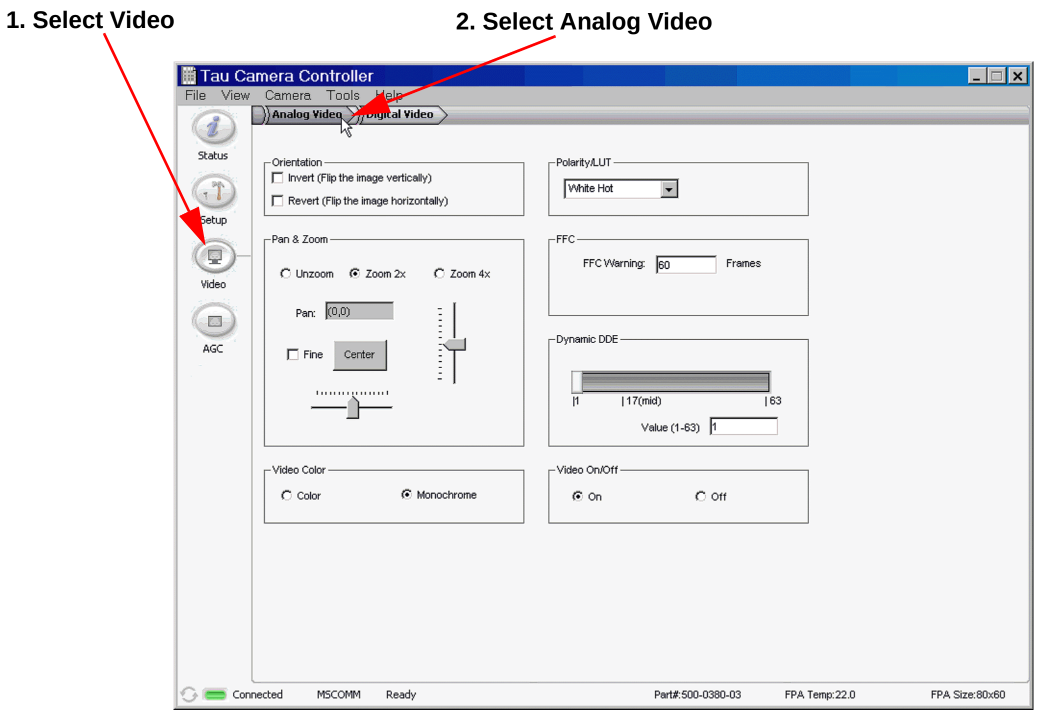


Figure 3-6: FLIR Camera Controller Analog Video Tab

Image-Orientation Mode: Two Image-Orientation mode selections are provided. Select one or both to change the orientation of the video image.
(Invert/Revert functions will be supported in July 2009.)

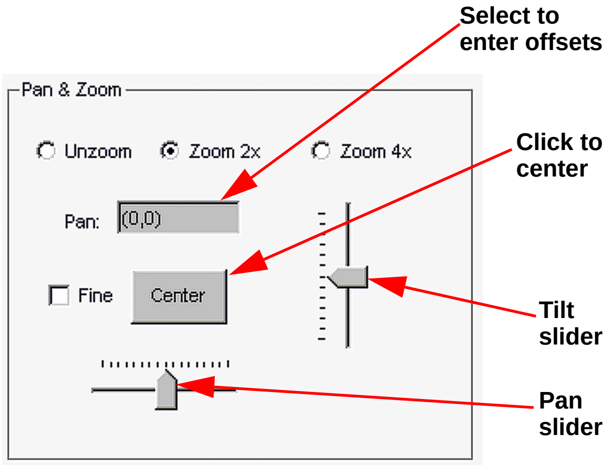
Invert: The normal image is flipped vertically. The pixel on the upper-left corner of the detector array is displayed on the lower-left corner of the video display in Invert mode. Invert is used when mounting the camera upside-down.

Revert: The normal image is flipped horizontally. The pixel on the upper-right corner of the detector array is displayed on the upper-left corner of the video display in Revert mode. Revert mode produces a mirror-image of Normal mode; use for applications where the camera is imaged through a fold-mirror.

Note

Any time the image orientation mode is changed, a flat-field correction takes place.

Pan & Zoom, Zoom: The Tau camera has a built-in 2X and 4X digital zoom capability. The **Zoom** checkboxes are used to turn on/off the camera zoom. With the **Unzoom** box checked, the Tau camera displays the full sensor array image (NTSC: 320x240 pixels or PAL 320x256 pixels). When the **Zoom 2x** box is checked, a smaller central region of the sensor array is mapped to the video output creating the zoom effect. For NTSC and PAL video formats in zoom mode, 160x120 and 160x128 pixels, respectively, are mapped to the analog video output. When the **Zoom 4x** box is checked, 80x60 (NTSC) and 80x64 (PAL) pixels, respectively, are mapped to the analog video output. This reduced region of the array is called the zoomed array region.

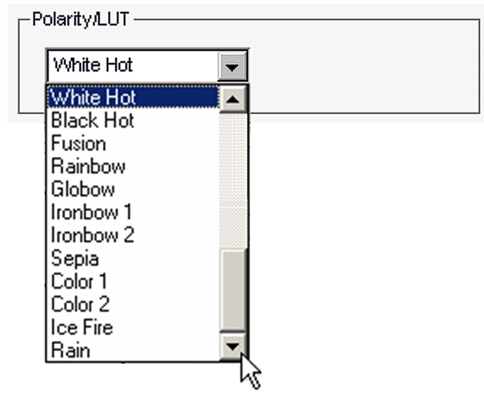


Pan & Zoom, Pan: When in either zoomed mode, you can move the zoomed array region within the full array area. This digitally simulates panning and tilting. Panning and tilting are defined as moving the camera image in the horizontal and vertical axes, respectively.

You can adjust the vertical and horizontal sliders to move the zoomed array region.

When the fine box is not checked the slider controls move the zoomed image from edge to edge of the full sized array. Checking the fine box increases the sensitivity of the slide control so that the zoomed array moves one half the total range but all values are achievable.

Simple experimentation while viewing the displayed image will quickly give you familiarity with this feature.



Polarity/LUT: The Tau camera detects and images the temperatures in a given scene. Within the camera, these temperatures are mapped (as determined by the AGC algorithm selected) to a range of 0 to 256 values. In a black and white display mode, this range is converted to shades of grey with, for example, 0 being totally black and 256 being totally white. The 0 to 256 grayshades range sensed is referenced to a Look-Up Table (LUT) permanently stored in the camera to convert the scene to a video image. Different LUTs are available to change the appearance of the displayed image. The most common selection is either White Hot (hotter objects appear brighter than cooler objects in the video display) or Black Hot (hotter objects appear darker than cooler objects). Since the difference between these two modes simply reverses the choice of darker or lighter for temperature extremes, this is sometimes referred to as Polarity. Other color LUTs are available as shown below.

Figure 3-7 shows each of the LUTs as displayed in Test Pattern Ramp Mode starting with the upper left: White Hot, Black Hot, Fusion, Rainbow, Globow, Ironbow1, Ironbow2, Sepia, Color1, Color2, Ice Fire and Rain. Select one of these LUTs from the pull-down menu to view your image displayed using the LUT you choose.

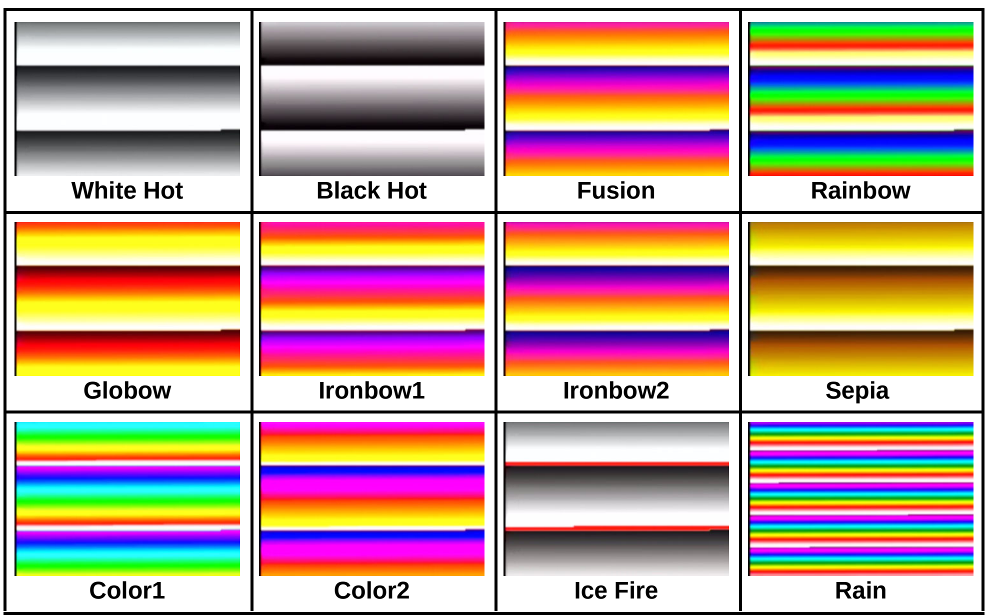


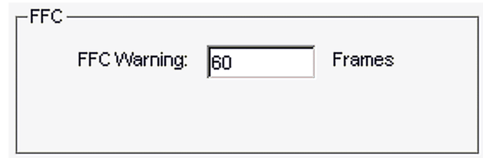
Figure 3-7: Look-Up Table Options

Simple experimentation with this feature while viewing the video image will give you familiarity. Remember that you must click the **Save Settings** button on the **Setup** tab to save the LUT settings as default at power-up.

Note

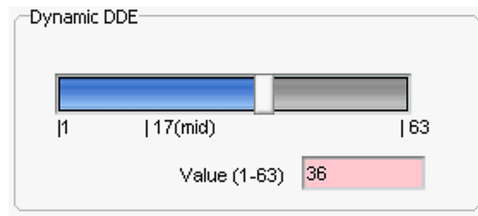
The setting of the Polarity/LUT mode will not affect the digital data output.

Flat-Field Correction (FFC): The Tau automatically performs flat-field corrections (see paragraph "Flat-Field-Correction Mode:" on page 3-11). A green square is displayed on your video monitor as a warning that the FFC is going to take place. Use this function to set the number of analog video frames (33ms NTSC, 40ms PAL) during which the warning will be displayed. The time period, specified in frames, can range from 0 to 30,000 frames. The factory setting of 60 frames equates to a two second warning. Setting the **Warn Time** to zero turns off the warning.



Dynamic Digital Detail Enhancement (DDE) filter:

The DDE algorithm sets edge enhancement dynamically proportional to the number of bins occupied in the image histogram.



In a high dynamic range scene the gain will be higher than in a low dynamic range scene. This allows faint details to be visible in high dynamic range scenes without increasing temporal and fixed pattern noise in low dynamic range scenes.

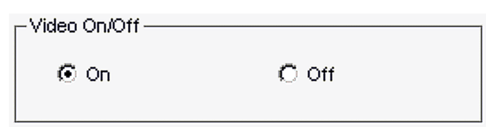
The DDE filter operates independently from the AGC and will enhance edges without effecting brightness or contrast. The valid range of Dynamic DDE setting is from 1 to 63 with 17 being the neutral setting where the filter has no effect. Settings below 17 will smooth the image reducing the appearance of sharp edges. Higher DDE settings will enhance all image non-uniformities resulting in a very detailed but grainy picture especially in high dynamic range scenes. Typical factory settings are between 25 and 30. Settings from 18 to 39 are normal imaging modes where the edge enhancement can be tuned for the scene. Use the slider to adjust the setting, or select the text field and type in the desired setting.

Note

In 14-bit Raw mode, selecting the DDE mode will not affect the digital data output.

Video Color: Select color or monochrome for the analog video output. If monochrome is selected then the analog bandwidth is increased to provide better spacial resolution in the horizontal direction.

Video On/Off: This feature allows you to turn off the analog video output which will result in some power savings (approximately 55mW).



3.10 Digital Video Tab

Tau offers a LVDS interface digital output that can be configured in four modes. Changing these modes will have *no* effect on the *analog* (NTSC or PAL) signal. In order to access the digital output, you must use an advanced interface as described in Chapter 4, Tau Digital Data Channel. See the Tau Electrical Interface Control Document (102-PS220-41) for information on how to access digital video for LVDS, BT 656, and CMOS.

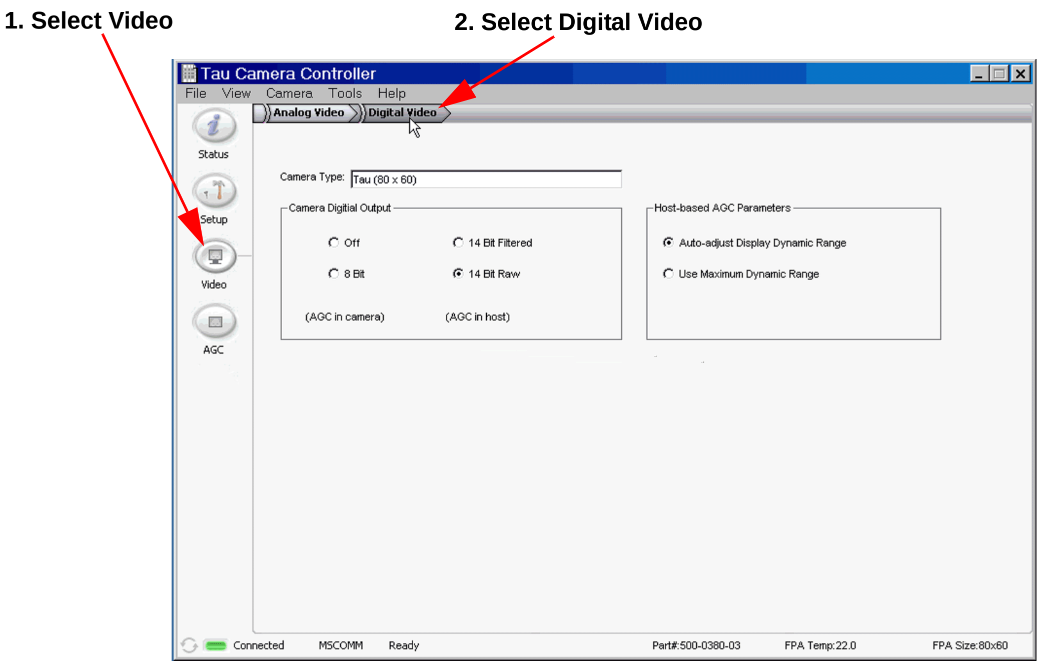


Figure 3-8: FLIR Camera Controller Digital VIdeo Tab

The settings that affect the digital data stream are described below.

Off: The digital data stream coming from the Tau camera is turned off.

8-bit: Data from the 320x240 (NTSC) or 320x256 (PAL) video pixels is provided after application of the current Automatic Gain Control (AGC) and Dynamic Detail Enhancement (DDE). The 8-bit data is essentially a digital version of the same data provided on the analog video channel.

14-bit Filtered: Data from 322x256 pixels is provided prior to video processing modes in the 8-bit data described above. The 14-bit data is the *filtered* data to include the Dynamic Detail Enhancement (DDE) and will appear gray when saving 16-bit TIFF files.

14-bit Raw: Data from 322x256 pixels is provided prior to all video processing and does not include the Dynamic Detail Enhancement (DDE). The 14-bit data is the 'raw' data and will also appear gray when saving 16-bit TIFF files.

Note

AGC mode will affect the digital data output if Camera Digital Output mode is set to 8-bit data.

3.11 AGC Tab

The **AGC** tab, shown in Figure 3-9, controls the Automatic Gain Control (AGC) mode or algorithm along with selectable parameters. Only one mode can operate at a time and is selected by clicking one of the **Algorithm** buttons in the upper left portion of the window. Parameters for a given mode are contextually made available depending on which mode is selected. The Region of Interest (ROI) for the AGC mode is adjustable as well (see paragraph 3.12).

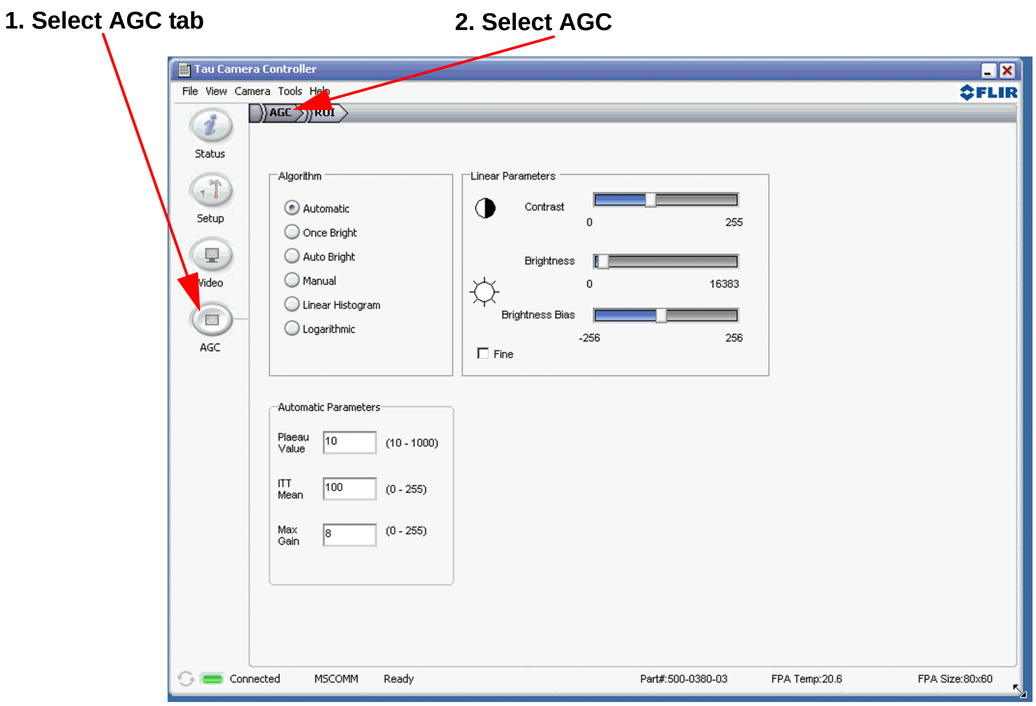
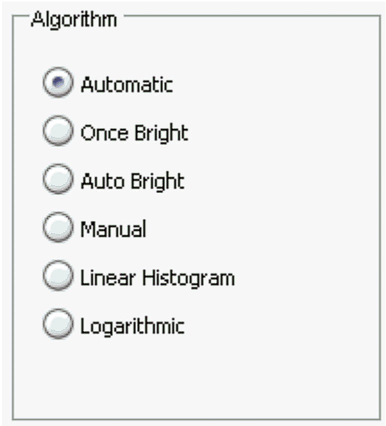


Figure 3-9: FLIR Camera Controller AGC Tab

Note

FLIR has invested heavily in designing high quality AGC algorithms. The default mode (Automatic) along with the default parameter settings for the Automatic AGC mode have been proven to offer the best image quality for generalized scene imaging. Also, be aware that you can make AGC adjustments that will configure the Tau camera to produce no image (all black or all white). Restoring the **Factory Defaults** *on the* **Setup Tab** *will return the camera to its factory default state and likely restore normal camera operation.*

AGC Modes: The Tau provides six AGC algorithms for Image-Optimization:



Automatic: This is the most sophisticated algorithm and for most imaging situations, the best all-around choice. This factory default along with the default parameter settings should be used in general imaging situations. In **Automatic**, image contrast and brightness are optimized automatically as the scene varies. This mode provides an AGC which is based on a histogram-equalization algorithm. Controls for the **ITT Mean** (gray scale mid-point), **Max Gain** (AGC gain) and **Plateau Value** are enabled.

The histogram equalization used in the automatic mode scales the 14-bit to 8-bit transfer function based on the number of pixels in a bin. The more pixels in a bin, the higher the gain. But the Plateau value is the pixels/bin limit when the transfer function is maximized. Normally 250 is the plateau value for imaging cameras when more contrast is desired.

This algorithm analyzes the scene content in real time and redistributes the dynamic range of the scene. The goal of this redistribution is that every one of the 128 bins of display dynamic range has an equal number of pixels in it. This method tends to give better scene contrast under conditions where the scene statistics are bimodal (for example, a hot object imaged in a cold background. It should be noted that the heat range in a given scene is not divided evenly across the grey levels sent to be displayed. Instead, the AGC algorithm analyzes the scene and distributes the dynamic range to best preserve statistical scene content (populated regions of the histogram) and display a redistributed scene representation.

Once Bright: In this mode, the brightness (level) is calculated as the mean of the current scene at the execution of the command (when the **Once Bright** button is selected). The scene is mapped to the analog video using a linear transfer function. Image contrast can be adjusted by the **Contrast** slider. This is the only user adjustable parameter. Upon entry into the once bright mode, the currently-stored value of contrast is applied (i.e. the power-on defaults or the last saved values).

Auto-Bright: In this mode, the brightness (level) is calculated as the mean of the current scene just as in **Once Bright** mode. The difference with **Auto-Bright** is that the values selected for the start and end of the linear transfer function are automatically updated in real-time, not only at the start of AGC mode selection. The **Brightness Bias** offsets the displayed image in intensity. Upon entry into the auto bright mode, the currently-stored values of **Contrast** and **Brightness Bias** are applied (i.e. the power-on defaults or the last saved values).

Manual: In this mode, image **Contrast** (gain) and **Brightness** (level) are entered completely manually via the sliders. The scene is mapped using a linear transfer function. Upon entry into the manual mode, currently-stored values of brightness and contrast are applied (i.e. the power-on defaults or the last saved values).

Linear Histogram: Image contrast and brightness (gain and level) optimized automatically based upon scene statistics using a linear transfer function. Controls for the **ITT Mean** (sets grey scale midpoint) and **Max Gain** (AGC gain) are adjustable by entering the value in the **Automatic Parameters** section. The Linear Histogram algorithm uses scene statistics to set a global gain and offset (contrast and

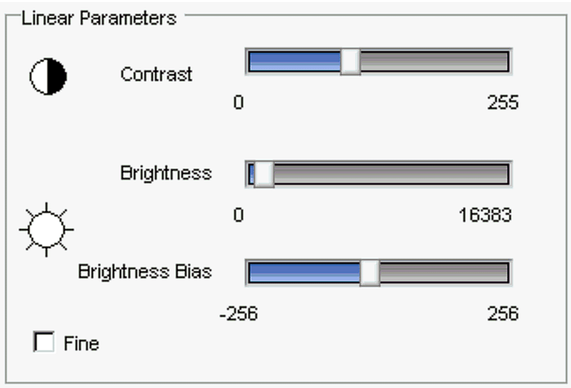
brightness) for the image. Upon entry into the linear histogram mode, the currently-stored values are applied (i.e. the power-on defaults or the last saved values).

Logarithmic: The Logarithmic AGC algorithm operates identically to the Linear Histogram algorithm discussed above, except that the transfer function applied is logarithmic as opposed to linear.

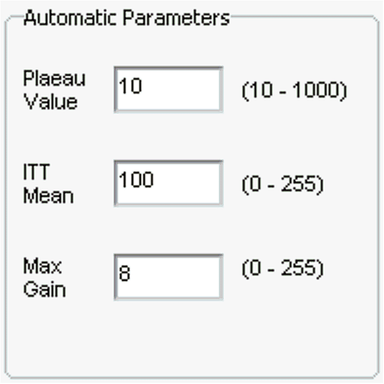
Note

In Manual mode and Once Bright mode, the brightness setting must be updated as the camera temperature changes. To avoid this issue, it is recommended to use Automatic or Auto-Bright modes when possible. Also, AGC mode will only affect the digital data output if the Digital Video output mode is set to 8-bit data. The 14-bit digital data bypasses the AGC sections of digital processing.

Linear Parameters: Used for fine tuning the **Auto Bright**, **Once Bright**, and **Manual** modes, these settings are contextually active depending on which **Algorithm** is selected. Each of their settings is described above.



Automatic Parameters: Used for fine tuning the **Automatic**, **Linear Histogram**, and **Logarithmic** modes, these settings are contextually active depending on which AGC algorithm is selected. Each of their settings is described above as they pertain to the particular **Algorithm**.



3.12 ROI Tab

The Tau camera allows the user to set a Region of Interest (ROI) or a rectangle of pixels on the sensor array that the AGC algorithm will use for its calculations. The ROI can be set for either the entire frame size (0,0 : 320,256) or some smaller portion as shown below. The **ROI** tab, shown in Figure 3-10, provides both a Window Editor and text entry coordinates to control the size and location of the Region of Interest (ROI).

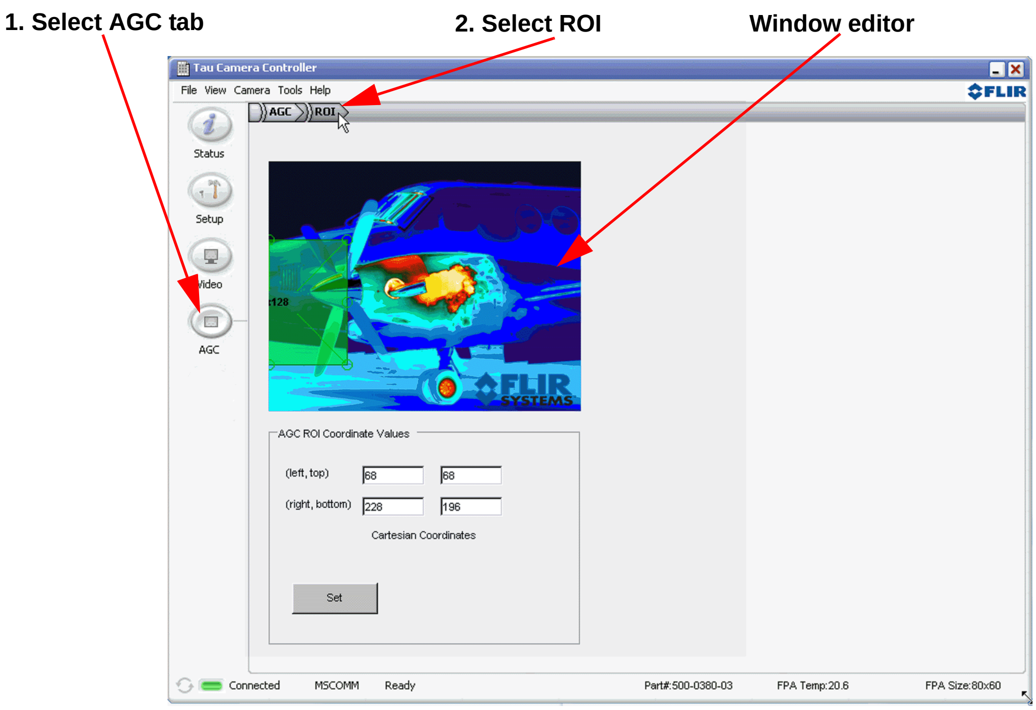
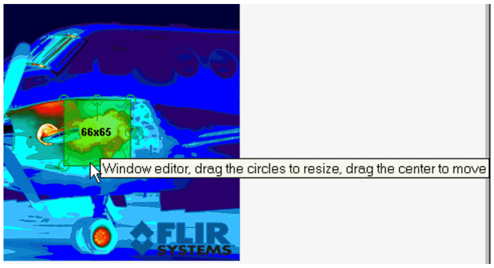
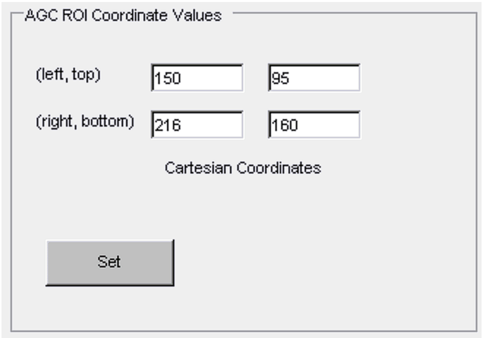


Figure 3-10: FLIR Camera Controller ROI Tab

Window Editor: Use the mouse to drag the green ROI rectangle to any location on the FPA. The size of the ROI rectangle (in pixels) is displayed. To change the size of the ROI rectangle, drag one of the corner or side bubbles.



AGC ROI Coordinate Values: The settings use an X-Y coordinate system with (0,0) being at the top left hand corner of the sensor array and specify two corners of the ROI rectangle. The upper two numbers marked (left,top) are the pixel coordinates of the upper left corner of the ROI rectangle. The lower two numbers marked (right,bottom) define the lower right corner of the ROI rectangle. In the example at the right, the ROI is specified as a ROI rectangle 66x65 pixels located 150 pixels from the left side and 216 pixels from the top of the FPA.



4 Tau Digital Data Channel

Tau provides a digital data channel that outputs the camera's data in a digital format. This channel can be used in conjunction with commercially-available digital frame grabbers, digital displays, or custom receive electronics. It can also be used with FLIR's Ethernet Adapter. For Tau users with embedded or specialty applications that require custom control software, a Software Developer's Kit (SDK) is available to support your development efforts. The SDK accessory is described in the Accessories portion of this User's Manual. Using the Digital Data Channel is an advanced regime that should only be attempted by qualified customers. The Appendices contain details for the Digital Data Channel.

The digital data channel can be configured to output 14-bit data after application of calibration (Non Uniformity Correction or NUC) terms. This mode is most useful for external signal-processing and/or analysis of the camera output. The digital channel can also be configured to provide 8-bit data after application of video processing algorithms (e.g. 'Automatic' AGC mode, white-hot/black-hot polarity, image orientation, DDE filtered, and on-screen symbols). The 8-bit data is essentially a digital version of the video stream provided on the analog video channel and is therefore more appropriate than the 14-bit data for interfacing to a digital display.

The digital data channel employs serial low-voltage differential signaling (LVDS). The channel consists of three signal lines—a clock, a composite sync (frame sync and data valid), and serial data. This is a modern high speed interface employing a twisted pair current loop architecture. National Semiconductor offers a good introduction and overview in the following document: http://www.national.com/appinfo/lvds/files/lvds_ch1.pdf

A serial-in-parallel-out (SIPO) module is available from FLIR for converting the serial data to 14-bit parallel LVDS output (plus frame sync, line sync, and pixel clock). The parallel data can be captured using a frame-grabber board installed in a PC.

One frame grabber possibility is the National Instruments IMAQ PCI-1422 board using digital interface cable part number 308-0013-00. Another frame grabber option is the Bit Flow RoadRunner Model 14-M board using digital interface cable part number 308-0016-00-03. Both of these computer-based frame grabber boards require third-party software not offered or supported by FLIR.

FLIR supplies camera setup files for both the IMAQ and Bit Flow frame grabber boards, but FLIR does not formally support their use, nor do we claim or guarantee that these setup files will be suitable for any particular use or application.
Refer to http://www.corebyindigo.com/service/softwareupdates.cfm

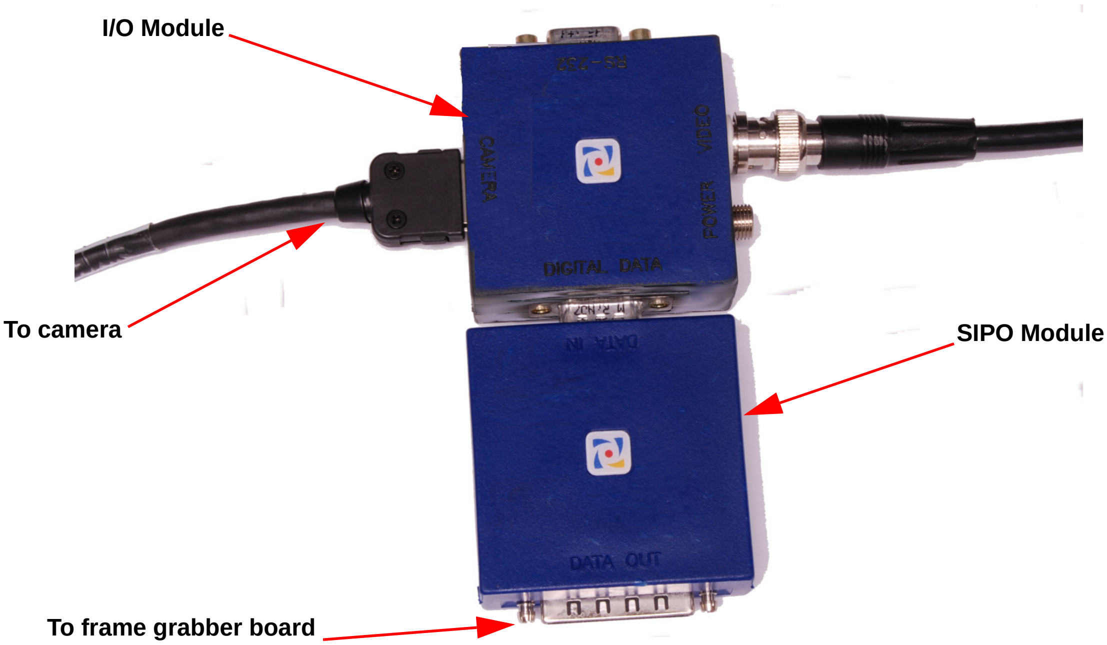
4.1 Using the Digital Data Channel

Note

The following instructions assume that you have purchased the optional serial-to-parallel-out (SIPO) accessory module with parallel data cable and Photon Replicator Board. If you are using the Ethernet module, follow the instructions provided with that device. If you are using custom cabling and/or interface electronics, contact FLIR Customer Support at (805) 964-9797 if you need additional assistance.

Follow the steps in paragraph 3.1 "Operation of the Tau camera using the Photon development kit" on page 3-1 for basic operation of the Tau camera. After verifying that the camera is operating properly, disconnect power from the I/O Module.

Step 1 Connect the SIPO accessory module directly to the three-row DB-15 connector on the Interface Module labeled **DIGITAL DATA** as shown below. A cable is NOT required.



Step 2 Connect the parallel data cable to the mating connector on the SIPO module. Connect the other end to the frame-grabber board installed in your PC.

Note

The parallel data cable is specific to a particular frame grabber. Contact the manufacturer of the frame grabber to make sure you have the correct cable.

Step 3 Follow instructions included with the frame grabber for selecting the camera configuration file included with the SIPO module.

Step 4 Reapply power to the Interface Module. This will power-up both the Tau camera and the SIPO module, and digital data will begin streaming.

Step 5 If desired, change the digital data mode using the FLIR Camera Controller software in the **Digital Video** tab.

5.1 Input Power

The Tau camera operates from DC power per the specifications given below. It is common in simple operational scenarios to use an inexpensive wall-powered adapter. This type of adapter is what is included with the Accessory Kit. The connector pin-out tables indicate where power is to be applied (PWR_IN and GND pins).

The camera operating in a steady-state condition consumes less than 1W of power. During start up or when the shutter is operating for the camera's periodic calibration, peak power levels of 5W (sustained for less than one second) are typical.

Caution!

Reversing the polarity of the input power will damage the camera's internal power supply. This damage will not be covered under the camera warranty.

Table 5-1: Input Power Requirements

Parameter	Baseline Value	Comment
Minimum voltage	4.0 V	Absolute minimum is 4 V
Maximum voltage	6.0 V	Absolute maximum is 6 V
Nominal Load Power	$\leq$ 1.0 W	Typical power is 0.85 mW with digital output enabled ONLY

5.2 Hirose 50-Pin Connector

In the Tau camera's simplest form (no accessories attached), one connector provides the electrical interface. This connector is a 50-pin Hirose board-to-board style connector, per Hirose Part Number: DF12-50DS-0.5V(86). Hirose offers a variety of mating connectors including their SFM(L), SMT, and SFSD style products. The primary Tau connector at the rear of the camera is identified in the figure below:

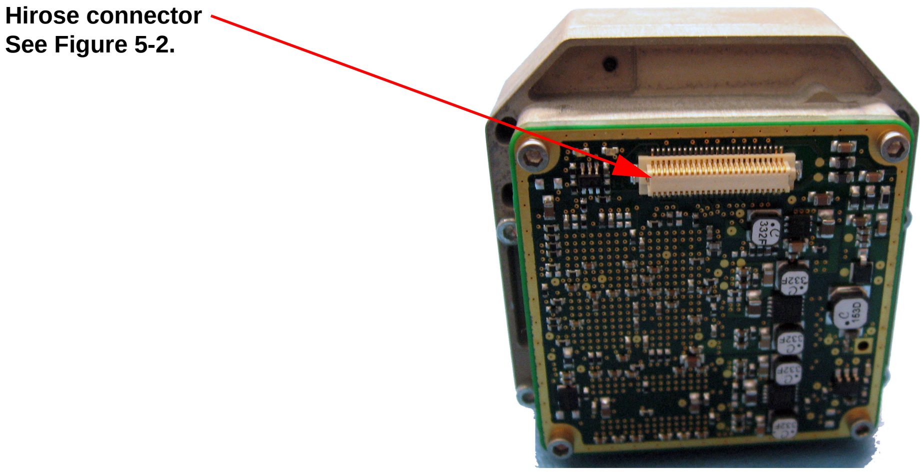


Figure 5-1: 50-Pin Hirose Connector Interface (DF12-50DS-0.5V(86))

Table 5-2 below identifies the function of each pin on the standard surface mount mating connector, Hirose DF12-50DS-0.5V(86).

Table 5-2: 50-pin Hirose Connector Interface of the Tau Camera

Pin #	Signal Name	Signal Definition	Pin #	Signal Name	Signal Definition
1	RS232_TX	Primary serial communication transmit, data output 57600 baud	2	RS232_RX	Primary serial communication receive, data input 57600 baud
3	SPARE0	Not Used	4	SPARE1	Not Used
5, 17, 27,37, 41, 45	DGND	Ground	6, 18, 28,38, 42	DGND	Ground
7	LVDS_RX0_P	Not Used	8	LVDS_RX0_N	Not Used
9	LVDS_TX0_P	Digital Port1, clock, positive output	10	LVDS_TX0_N	Digital Port1, clock, negative output
11	LVDS_TX1_P	Digital Port1, Sync, Positive output	12	LVDS_TX1_N	Digital Port1, Sync Negative Output
13	LVDS_TX2_P	Digital Port1, Output data 1, Positive output	14	LVDS_TX2_N	Digital Port1, Output data 1, Negative output
15	LVDS_TX3_P	Not Used	16	LVDS_TX3_N	Not Used
19	XP15	Not Used	20	XP14	Not Used
21	XP13	Not Used	22	XP12	Not Used
23	XP11	Not Used	24	XP10	Not Used
25	XP9	Not Used	26	XP8	Not Used
29	XP7	Not Used	30	XP6	Not Used
31	XP5	Not Used	32	XP4	Not Used
33	XP3	Not Used	34	XP2	Not Used
35	XP1	Not Used	36	XP0	Not Used
39	XP_CLK_OUT	Not Used	40	XP_CLK_IN	Not Used
43	VID_OUT_H	Analog Video +	44	VID_OUT_L	Analog Video -
			46	3V3	3.3V output
47,49	MAIN_PWR_RTN	Input voltage ground	48, 50	MAIN_PWR	Input Voltage

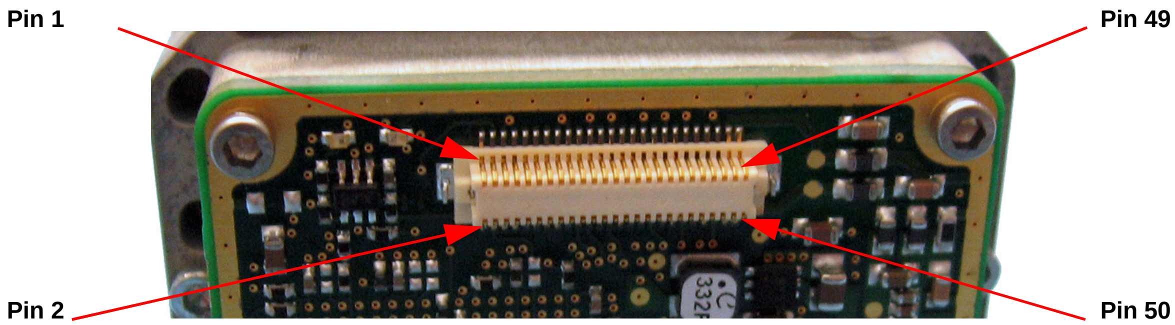


Figure 5-2: Mechanical Definition for 50-pin Interface Board

5.3 Analog Video Output

The Tau camera can be configured to provide either NTSC or PAL analog video output. These analog output standards allow direct video connection to common video display or recording devices such as TV monitors and VCRs. Typically, an analog monitor input signal is provided over a coaxial cable and uses either an RCA (consumer based electronics) or BNC (generally associated with professional or scientific equipment) style connector.

If you are creating a custom cable to carry the analog video signal from the Tau camera to your monitoring or recording device, you should use 75 Ohm characteristic impedance coaxial cable and terminate into a 75 Ohm monitor. These specifications represent standard video cabling and I/O and will likely be the default for any generic video receiving hardware you purchase. Per the pin function table, you will use the VIDEO_LO and VIDEO_HI pins for the analog video output signal. Specific video characteristics are given in the table below.

Table 5-3: Video parameters

Parameter	NTSC	PAL
Monochrome equivalent	RS-170A	CCIR
Frame rate	29.97 Hz	25 Hz
Update rate	30 Hz/7.5 Hz	25 Hz/8.3 Hz
Active video lines	480	510
# displayed detector samples	320 (H) x 240 (V)	320 (H) x 256 (V)

Note

Analog output is always NTSC/PAL compatible. Changes for reduced frame rate and reduced size array do not effect analog video format.

5.4 Command and Control Channel

Remote control of the Tau camera is provided via a RS-232 serial interface consisting of signals named RX, TX and GND using 3.3 volt signal levels. Chapter 3 provides information regarding remote control using the FLIR Camera Controller. Appendix B describes the serial communications protocol in detail for the Tau camera.

5.5 Digital Data Channel

Tau provides a digital channel with real-time serialized digital video. The camera outputs either 8-bit or 14-bit data using the SD_CLK±, SD_FSYNC± and SD_DATA± signals. Conversion of the digital data to a parallel format for data acquisition requires a serial-to-parallel converter accessory or an Ethernet Module which is also an accessory. Information regarding the digital data interface is provided in Chapter 4 and Appendix B.

A.1 I/O Module 333-0018-00

- Camera Connector: See Chapter 5.
- Power Connector: Mates to Switchcraft S760 Miniature Power Plug.
- Video Connector: Mates to 75Ω BNC twist-on plug.
- Serial Connector: Mates to DB9 Male.
- Digital Data Connector: Mates to Three-Row DB-15 Female.

Table A-1: I/O Module Power Connector Pin-Out

Pin #	Signal Name	Signal Definition
Pin	PWR	input power
Sleeve	PWR_RTN	input power return

Table A-2: I/O Module Video Connector Pin-Out

Pin #	Signal Name	Signal Definition
Pin	VIDEO	analog video output
Sleeve	VIDEO_RTN	analog video return

Table A-3: I/O Module Serial Connector Pin-Out

Pin #	Signal Name	Signal Definition
2	RX_232	RS232 Receive channel
3	TX_232	RS232 Transmit channel
5	DGND	Digital Ground
1,4, 6-9	NC	Spare (do not connect)

Table A-4: I/O Module Digital Data Connector Pin-Out

Pin #	Signal Name	Signal Definition
1	DATA_SYNC+	Digital data sync (LVDS high)
2	DATA1_OUT+	Digital data 1 output channel (LVDS high)
3	DATA2_OUT+	Digital data 2 output channel (LVDS high)
4	DATA_CLK+	Digital output channel clock (LVDS high)
6	DATA_SYNC-	Digital data sync (LVDS low)
7	DATA1_OUT-	Digital data 1 output channel (LVDS low)
8	DATA2_OUT-	Digital data 2 output channel (LVDS low)
9	DATA_CLK-	Digital output channel clock (LVDS low)
10	DGND	Digital ground
11	PWR	input power (connected to power connector pin)
12	PWR_RTN	input power return (connected to power connector sleeve)
13	NC	Spare (do not connect)
5,14,15	NC	Spare (do not connect)

B.1 Serial Communications Primary Interface

The camera is capable of being controlled remotely through an asynchronous serial interface consisting of the signals named RX, TX, and GND using *3.3 volt* signal levels.

Note

The camera is compatible with most RS232 drivers/receivers but does not implement signaling levels compliant with the RS232 standard voltage levels.

B.2 Serial Communications Protocol

- The required serial port settings are shown in Table B-1.
- The camera does not generate an outgoing message except in reply to an incoming message.
- The camera generates an outgoing reply to each incoming message.
- All messages, both incoming and outgoing, adhere to the packet protocol defined in Table B-2 and the subparagraphs that follow. The first byte i.e., the Process byte is transmitted first followed by the rest of the bytes in the order specified.
- All multi-byte arguments defined herein uses big-endian ordering (MSB first).
- The serial inter-byte timeout is factory set to 100ms
- Only use the function commands listed in Table B-4. Unsupported commands may corrupt the camera's software.
- For reference only, a sample command and response is shown in Table B-5.

Table B-1: Serial Port Settings

Parameter	Value
Baud rate:	57600
Data bits:	8
Parity:	None
Stop bits:	1
Flow control:	None

Table B-2: Serial Packet Protocol

Byte #	Upper Byte	Comments
1	Process Code	Set to 0x6E on all valid incoming messages Set to 0x6E on all outgoing replies
2	Status	See Table B-3
3	Reserved	
4	Function	See Table B-4
5	Byte Count (MSB)	
6	Byte Count (LSB)	
7	CRC1 (MSB)	
8	CRC1 (LSB)	
	(Data)	See argument data bytes in Table B-4
...	(Data)	
N	(Data)	
N+1	CRC2 (MSB)	
N+2	CRC2 (LSB)	

B.3 Status Byte

For all reply messages, the camera sets the Status Byte as shown in Table B-3 to indicate the receipt of the previous incoming message.

Table B-3: Status Byte Definition

Status Byte Value (hex)	Definition	Description
0x00	CAM_OK	Function executed
0x01	CAM _BUSY	Camera busy processing serial command
0x02	CAM _NOT_READY	Camera not ready to execute specified serial command
0x03	CAM _RANGE_ERROR	Data out of range
0x04	CAM _CHECKSUM_ERROR	Header or message-body checksum error
0x05	CAM _UNDEFINED_PROCESS_ERROR	Unknown process code
0x06	CAM _UNDEFINED_FUNCTION_ERROR	Unknown function code
0x07	CAM _TIMEOUT_ERROR	Timeout executing serial command
0x09	CAM _BYTE_COUNT_ERROR	Byte count incorrect for the function code
0x0A	CAM _FEATURE_NOT_ENABLED	Function code not enabled in the current configuration.

B.4 Function Byte

- The list of valid commands that can be set in the Function Byte is shown in Table B-4.
- For all reply messages, the camera will echo back the Function Byte of the previous incoming message.
- For all commands in which the byte count is listed in Table B-4 as either 0 or some non-zero value, the camera will change the value of the specified parameter according to the incoming data bytes if there are any (i.e., the camera shall set the parameter) or it will reply with the current value of the parameter if the incoming message contains no data bytes (i.e., the camera shall get the parameter).

Table B-4: RS232 Function Codes

Function Code (hex)	Command	Description	Byte Count	Argument (i.e, Data Bytes) (hex)	Notes
0x00	NO-OP	No Operation.	Cmd:0 Resp:0	None	
0x01	SET_DEFAULTS	Sets all current settings as power-on defaults	Cmd:0 Resp:0	None	
0x02	CAMERA_RESET	Commands a soft camera reset to the default modes	Cmd:0 Resp:0	None	
0x03	RESET_FACTORY_ DEFAULTS	Resets camera with factory header values	Cmd:0 Resp:0	None	
0x04	SERIAL_NUMBER	Gets and sets the serial number of the camera	Get Cmd: 0	None	
			resp: 4	camera serial number	
0x05	GET_REVISION	Gets the firmware / software version	cmd: 0	None	
			Resp: 8	Bytes 0-1: S/W major version Bytes 2-3: S/W minor version Bytes 4-5: F/W major version Bytes 6-7: F/W minor version	
0x06	STATUS_REQUEST	Request status and settings of camera	Cmd:0	None	
			Resp:4	Camera status	
0x0A	GAIN_MODE	Gets and sets the dynamic-range-control mode	Get Cmd: 0		
			Set Cmd:2 & Resp: 2	0x0002 = High Gain Only 0x0003 = Manual (no switching)	
0x0B	FFC_MODE _SELECT	Gets and sets the Flat Field Correction (FFC) Mode	Get Cmd: 0	None	
			Set Cmd:2 & Resp: 2	0x0000 = Manual 0x0001 = Automatic 0x0002 = External	
0x0C	DO_FFC	Commands a flat field correction	Cmd:0 Resp:0	None	
0x0D	FFC_PERIOD	Gets and sets the interval (in frames) between automatic FFC	Get Cmd: 0	None	
			Set Cmd: 2	Number of 30Hz frames (~33ms)	
			Resp: 2	Number of 30Hz frames (~33ms)	

Table B-4: RS232 Function Codes

Function Code (hex)	Command	Description	Byte Count	Argument (i.e, Data Bytes) (hex)	Notes
0x0E	FFC_TEMP_ DELTA	Gets and sets the temperature difference used to trigger automatic FFC.	Get Cmd: 0	None	
			Set Cmd: 2	Delta temp in steps of 0.1C	
			Resp: 2	Delta temp in steps of 0.1C	
0x0F	VIDEO_MODE	Gets and sets the video signal mode. Setting Freeze frame freezes the image. Setting Zoom zooms the image by 2x and 4x.	Get Cmd:0	None	
			Set Cmd: 2 & Resp: 2	0x0000 = Real time 0x0001 = Freeze frame 0x0004 = Zoom	
0x10	VIDEO_LUT	Gets and sets the analog video LUT or intensity transform.	Get Cmd: 0	None	
			Set Cmd: 2 & Resp: 2	0x0000 = White hot 0x0001 = Black hot 0x0002 = Fusion 0x0003 = Rainbow 0x0004 = Globow 0x0005 = Ironbow1 0x0006 = Ironbow2 0x0007 = Sepia 0x0008 = Color1 0x0009 = Color2 0x000A = Ice and fire 0x000B = Rain 0x000C = Custom #1	
0x11	VIDEO_ ORIENTATION	Gets and sets the analog video orientation. Digital data is unaffected by the revert setting.	Get Cmd: 0	None	
			Set Cmd: 2 & Resp: 2	0x0000 = Normal 0x0001 = Invert 0x0002 = Revert 0x0003 = Invert + Revert	
0x12	DIGITAL_ OUTPUT_MODE	Gets and sets the digital output channel mode	Get Cmd: 0	None	
			Set Cmd: 2 & Resp: 2	0x0000 = 14-bit data 0x0001 = 8-bit data 0x0002 = digital off 0x0003 = 14-bit unfiltered 0x0004 = 8-bit inverted 0x0005 = 14-bit inverted 0x0006 = 14- bit inverted unfiltered	

Table B-4: RS232 Function Codes

Function Code (hex)	Command	Description	Byte Count	Argument (i.e, Data Bytes) (hex)	Notes
0x13	AGC_TYPE	Gets and sets the image optimization mode	Get Cmd: 0	None	
			Set Cmd: 2 & Resp: 2	0x0000 = automatic 0x0001 = once bright 0x0002 = auto bright 0x0003 = manual 0x0005 = linear	
0x14	CONTRAST	Gets and sets the manual contrast value	Get Cmd: 0	None	
			Set Cmd: 2 & Resp: 2	Contrast value (0x0000 to 0x00FF)	
0x15	BRIGHTNESS	Gets and sets the manual brightness value	Get Cmd: 0	None	
			Set Cmd: 2 & Resp: 2	Brightness value (0x0000 to 0x3FFF)	
0x18	BRIGHTNESS_BIAS	Gets and sets the brightness bias value in the auto bright mode Valid range is +2048 to -2048 decimal MSB is the sign bit	Get Cmd: 0	None	
			Set Cmd: 2 & Resp: 2	Brightness bias value (2's complement : 0x0000 to 0x0FFF)	
			Set Cmd: 2 & Resp: 2	0x0000 = disabled (off) 0x0001 = on, Fahrenheit scale 0x0002 = on, Centigrade scale	
0x20	READ_TEMP_SENSOR	Gets the FPA temp. in Celsius x 10 or raw counts (e.g. value of 512 decimal represents 51.2C) Sign bit is the MSB.	Set Cmd: 2 & Resp: 2	0x0000 = temp in C*10 0x0001 = temp in raw counts	
0x21	EXTERNAL_SYNC	Enables or disables the external sync feature	Get Cmd: 0	None	
			Set Cmd: 2 & Resp: 2	Ext sync mode 0x0000 = disabled 0x0001 = slave 0x0002 = master	
0x25	TEST_ PATTERN	Gets and sets the test pattern mode. Before turning on the test pattern, turn off the correction terms and set the flat field and the gain mode to manual.	Get Cmd: 0	None	
			Set Cmd: 2 & Resp: 2	0x0000 = test pattern off 0x0001 = ascending ramp 0x0003 = big vertical	
0x3C	FFC_WARN_TIME	Time to display the FFC imminent icon in number of frames before the flat field happens	Get Cmd: 0	None	
			Set Cmd: 2 & Resp: 2	Bytes 0 to 1: Time in frames (Data Range is 0 to 600 frames)	

Table B-4: RS232 Function Codes

Function Code (hex)	Command	Description	Byte Count	Argument (i.e, Data Bytes) (hex)	Notes
0x3E	AGC_FILTER	Gets and sets the AGC ITT filter value	Get Cmd: 0	None	
			Set Cmd: 2 & Resp: 2	Bytes 0 to 1: ITT filter value 0 = immediate 1-255 = Numerator (Denominator = 256)	
0x3F	PLATEAU_LEVEL	Specifies the Plateau level for Plateau AGC	Get Cmd: 0	None	
			Set Cmd: 2 & Resp: 2	Data Range is 0 to 1000	
0x4C	AGC_ROI	Gets and sets the region of interest for AGC in normal and zoom mode. Tau uses 0,0=center and signed coordinates. When the Get Cmd byte count is 0, the ROI returned will be the normal ROI if camera is in normal mode or the zoom ROI if the camera is in zoom mode. If the Get Cmd byte count is 2, the first 8 bytes contain the normal ROI and second 8 bytes contain the zoom ROI. Data range for normal ROI is: **FPA 0604 NTSC** Left: -320,Top: -240, Right:320, Bottom:240 **FPA 0604 PAL** Left: -320,Top: -256, Right:320, Bottom:256	Get Cmd: 0	None	

Table B-4: RS232 Function Codes

Function Code (hex)	Command	Description	Byte Count	Argument (i.e, Data Bytes) (hex)	Notes
0x4C (cont)	AGC_ROI	Data range for zoom ROI is: **FPA 0604 NTSC 2X zoom** Left: -160,Top: -120, Right:160, Bottom:120 **FPA 0604 PAL 2X zoom** Left: -160,Top: -128, Right:160, Bottom:128 **FPA 0604 NTSC 4X zoom** Left: -80,Top: -60, Right:80, Bottom:60 **FPA 0604 PAL 4X zoom** Left: -80,Top: -64, Right:80, Bottom:64	Get Cmd: 0	None	
			Set Cmd: 8 & Resp: 8	Bytes 0-1: Left Bytes 2-3: Top Bytes 4-5: Right Bytes 6-7: Bottom	
0x55	ITT_MIDPOINT	Gets and sets the ITT midpoint offset	Get Cmd: 0	None	
			Set Cmd: 2 & Resp: 2	Data Range is 0 to 255	
0x66	CAMERA_PART	Gets the camera part number Response contains the part number. If the host system is little endian the bytes need to be reversed as the camera is big endian	Get cmd: 0	None	
			Response: 32	String(32)	

Table B-4: RS232 Function Codes

Function Code (hex)	Command	Description	Byte Count	Argument (i.e, Data Bytes) (hex)	Notes
0x6A	MAX_AGC_GAIN	Gets and sets the max value of video gain	Get Cmd: 0	None	
			Set Cmd: 2 & Resp: 2	Data Range 0 to 2048	
0x70	PAN_AND_TILT	Gets and sets the pan position(x axis) and the tilt position(y axis) when the camera is in zoomed mode	Get Cmd: 0	None	
			Set Cmd: 4 & Resp: 4	Bytes 0-1: Tilt position in rows relative to the center of the array (-68 to +68) Bytes 2-3: Pan position in columns relative to the center of the array(-82 to +82)	
0x79	SHUTTER_POSITION	Opens or closes the shutter	Get Cmd: 0	None	
			Set Cmd: 2 & Resp: 2	Shutter position 0x0000 = open 0x0001 = close	
0x2C	DDE_GAIN	Sets the gain of the DDE filter	Get Cmd: 0	None	
			Set Cmd: 2 & Resp: 2	Gain value (0x0000 to 0x00FF)	
0xE2	DDE_THRESHOLD	Sets the threshold of the DDE filter	Get Cmd: 0	None	
			Set Cmd: 2 & Resp: 2	Threshold value (0x0000 to 0x00FF)	
0xE3	SPATIAL_THRESHOLD	Sets the spatial threshold of the DDE filter	Get Cmd: 0	None	
			Set Cmd: 2 & Resp: 2	Threshold value is 0x0000 to 0x000F for manual DDE and 0x0100 to 0x013F for Auto DDE	

B.4.1 Byte Count Bytes

- On all incoming and outgoing messages, the Byte-Count Bytes are used to specify the total number of data bytes in the packet. (Note: the number of data bytes in the packet is not equal to the total number of bytes in the packet. For example, a No-Op serial command contains zero data bytes.)
- The Byte Count must be an even number from 0 to 0x1F4 (500 decimal).

B.4.2 CRC Bytes

- On all incoming and outgoing messages, two cyclical redundancy checks (CRCs) are calculated using CCITT-16 initialized to 0.
- CRC1 is calculated using only the first 6 bytes of the packet.
- CRC2 is calculated using all previous bytes in the packet (i.e. bytes 0 through N).

B.5 Example of the format of a serial message

Table B-5 describes the bytes that are transferred when the FFC_MODE_SELECT (0x0B) command is issued to the camera to set the mode to Auto (0x01) and to get the FFC mode:

Table B-5: Sample FFC_MODE_SELECT (0x0B) Command

Set Message sent to camera:							
Process Code	**Status**	**Reserved**	**Function**	**Byte Count**	**CRC**	**Data**	**CRC**
0x6E	0x00	0x00	0x0B	0x00 0x02	0x0F 0x08	0x00 0x01	0x10 0x21
Response from camera to set message:							
Process Code	**Status**	**Reserved**	**Function**	**Byte Count**	**CRC**	**Data**	**CRC**
0x6E	0x00	0x00	0x0B	0x00 0x02	0x0F 0x08	0x00 0x01	0x10 0x21
Get Message sent to camera:							
Process Code	**Status**	**Reserved**	**Function**	**Byte Count**	**CRC**	**Data**	**CRC**
0x6E	0x00	0x00	0x0B	0x00 0x00	0x2F 0x4A		0x00 0x00
Response from camera to get message:							
Process Code	**Status**	**Reserved**	**Function**	**Byte Count**	**CRC**	**Data**	**CRC**
0x6E	0x00	0x00	0x0B	0x00 0x02	0x0F 0x08	0x00 0x01	0x10 0x21

B.6 Description of serial commands

B.6.1 Camera Defaults

The RESET_FACTORY_DEFAULTS command sets the current settings to the factory default values. In order to save these values as power up defaults, it is necessary to do a SET_DEFAULTS command.

B.6.2 AGC algorithms

Use the AGC_TYPE command to select one of the following AGC algorithms:

- Automatic
- Once Bright
- Auto Bright
- Manual
- Linear
- Logarithmic

B.6.3 Pan and Tilt

The PAN_AND_TILT command controls this feature in the camera when the image is zoomed. It does not have any effect when the image is not zoomed. The center of the screen is considered as coordinate (0,0).

A positive number is needed to pan right and negative number to pan left. A pan value of 1 pans to the right by one column and a pan value of -1 pans to the left by one column from the center of the image.

A positive number is needed to tilt downwards and a negative number to tilt upwards. A tilt value of 1 tilts downwards by one row and a tilt value of -1 tilts upwards by one row from the center of the image.

When the image is being panned or tilted the ROI moves along with these coordinates. The limits for the zoom ROI have been set to one and a half times the number of rows and columns in the video. This is to enable a user to pan and tilt the zoomed portion of the image without any change in the AGC if the image being looked at does not change. This also means that the AGC of the image is also determined by portions of the image that is not being currently viewed.

B.6.4 DDE filter

The commands to control the DDE filter settings are DDE_GAIN to control the gain, DDE_THRESHOLD to control the DDE filter threshold, and SPATIAL_THRESHOLD to control the spatial threshold of the DDE filter. The image remains unchanged when the value of the DDE gain is 0 and 17. The image becomes unfocused/unsharpened when the value is between 1 and 15. The image becomes more sharpened when the value is above 17. Increasing the DDE threshold will make the edges sharper. For threshold values between 0 and about 50 the effect on the image is lesser and has a greater effect above approximately 50. Increasing the spatial threshold value will make the image look smoother.

The DDE filter has an automatic mode that when activated controls the DDE Gain using a combination of the Dynamic DDE setting and the scene dynamic range. The valid range of the Dynamic DDE setting is from 1 to 63. Dynamic DDE settings between 1 and 16, provide image smoothing, with a setting of 1 providing the most smoothing. A Dynamic DDE setting of 17 turns off the Dynamic DDE. A Dynamic DDE setting between 18 and 39 sets the imaging mode DDE Gain between 16 and 40. A Dynamic DDE setting of 40 or greater provides maximum enhancement but image artifacts may also be enhanced giving an image with some fixed pattern noise.

B.6.5 Digital data

The DIGITAL_OUTPUT_MODE command allows the users to select one of the following digital data options

- 14-bit data
- 8-bit data
- digital off
- 14-bit unfiltered
- 8-bit inverted
- 14-bit inverted
- 14- bit inverted unfiltered

B.7 Spare Serial Communications Channel

The camera provides a spare serial communications port consisting of the signals: RX2, TX2, and GND.

Note

This serial communications channel is intended for communication with RS-232 controllable systems.

B.8 Analog Video Interface

The camera provides an analog video on the signals named VIDEO_LO and VIDEO_HI.

When the VIDEO_LO signal is tied to ground, the analog video signal meets the timing and voltage requirements of either NTSC or PAL protocol. (The FLIR Camera Controller software allows you to select between NTSC or PAL video output formats. The NTSC analog video format is the default in all cameras.)

The analog video signal is intended to drive a 75-ohm load. Use of coaxial cable with 75 ohm characteristic impedance is strongly suggested

B.9 Digital Data Channels

The camera provides two digital ports.

- Port 1 consists of the signals SD_CLK+, SD_FSYNC+, and SD_DATA+.
- Port 2 consists of the signal LVDS_VID0±, LVDS_VID1±, and LVDS_VID2±.

Note

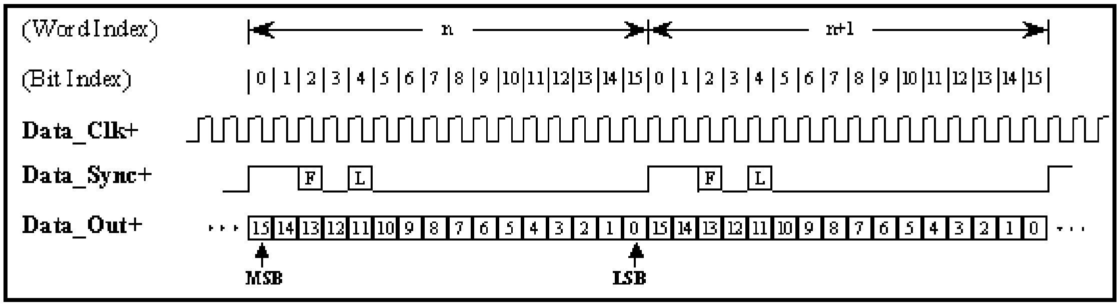
14-bit and 8-bit timing and format are identical except only 8 bits (LSBs) are available in 8-bit mode.
Port 2 is currently undefined—do not connect to these signals

All signals in the digital data interface employ low-voltage differential signaling (LVDS).

The clock rate of DATA_CLK± is 73.636 MHz.

The timing of the digital data interface is shown in Figure B-1 and Figure B-3.

The format of the digital output shall be is in Figure B-2.



F = frame sync; logic high on the word starting the frame, logic low otherwise
L = line sync; logic high during valid pixel data, logic low otherwise

Figure B-1: Digital Data Timing

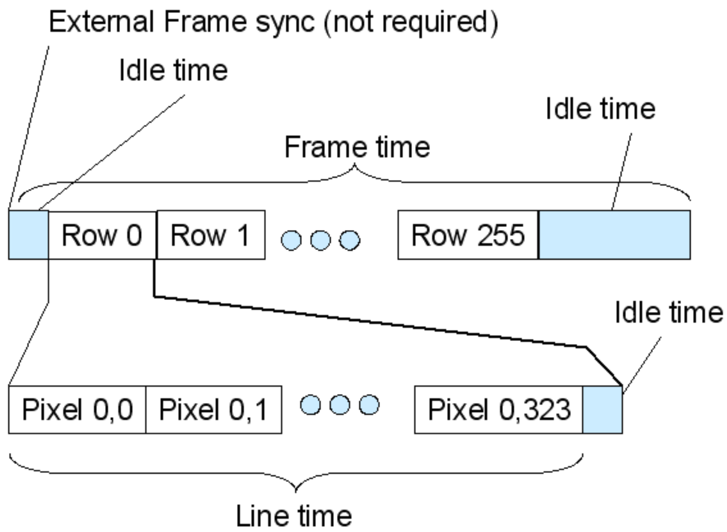


Figure B-2: Digital Data Format

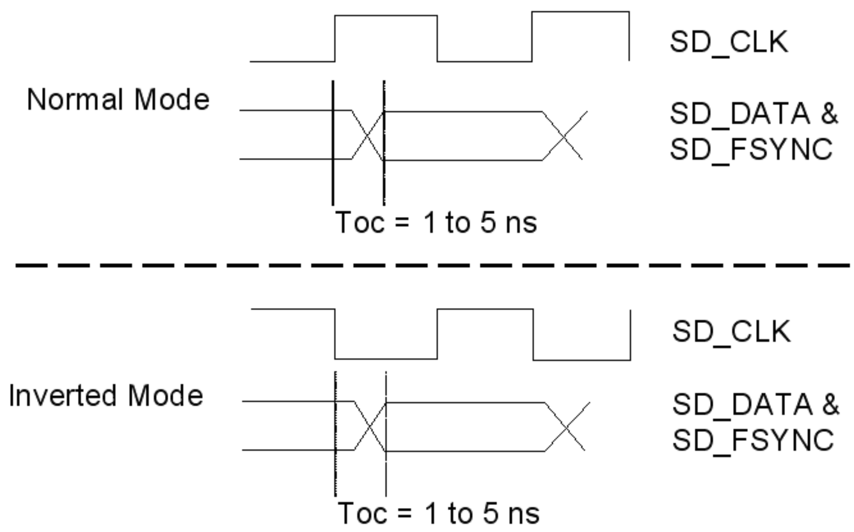


Figure B-3: Detailed Digital Data Timing

Appendix C Mechanical IDD Reference

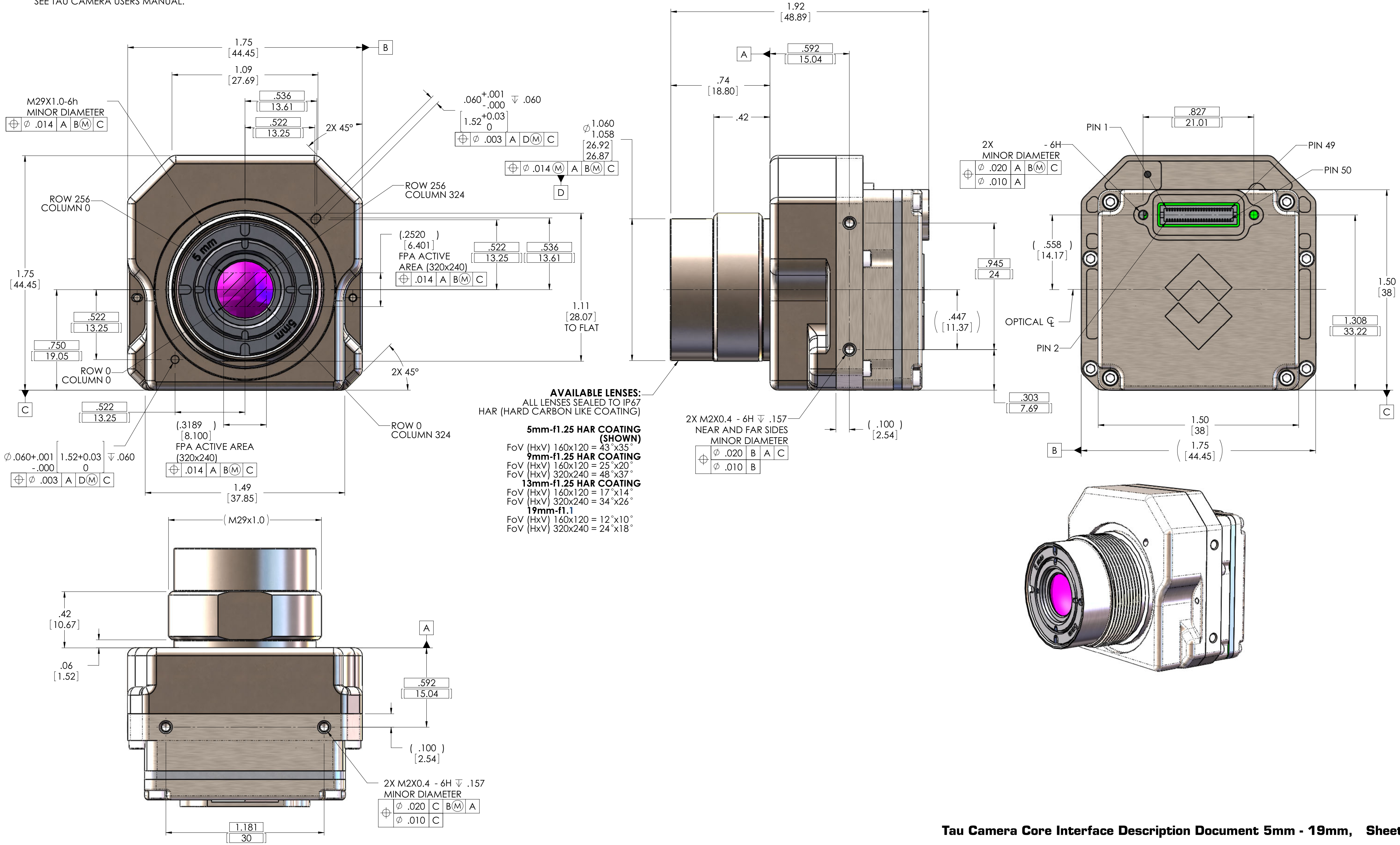
Due to export restrictions, limited data is available at
www.corebyindigo.com,
additional data can be obtained from your local sales representative or application engineer.

The following Mechanical Interface Description Documents (IDD) detail the outline and mounting for the Tau cameras. These documents are provided for reference only. You should consult your local sales representative or application engineer to obtain current IDD information. Also, the Tau Thermal Imaging Camera Core Data Sheet available from the website contains important mechanical interface data as well.

See:
http://www.corebyindigo.com/tau.

NOTES: UNLESS OTHERWISE SPECIFIED

1. TOLERANCES ALSO APPLY FOR 160x120 ARRAY SIZE.
2. CONNECTOR INTERFACE: HIROSE 50 PIN DF12-50DS-0.5V(86). MATING CONNECTOR P/N DF12(5.0)-50DP-0.5V(86). FOR PIN-OUT DESIGNATIONS SEE TAU CAMERA USERS MANUAL.



AVAILABLE LENSES:
ALL LENSES SEALED TO IP67
HAR (HARD CARBON LIKE COATING)

5mm-f1.25 HAR COATING (SHOWN)
FoV (HxV) 160x120 = 43°x35°

9mm-f1.25 HAR COATING
FoV (HxV) 160x120 = 25°x20°
FoV (HxV) 320x240 = 48°x37°

13mm-f1.25 HAR COATING
FoV (HxV) 160x120 = 17°x14°
FoV (HxV) 320x240 = 34°x26°

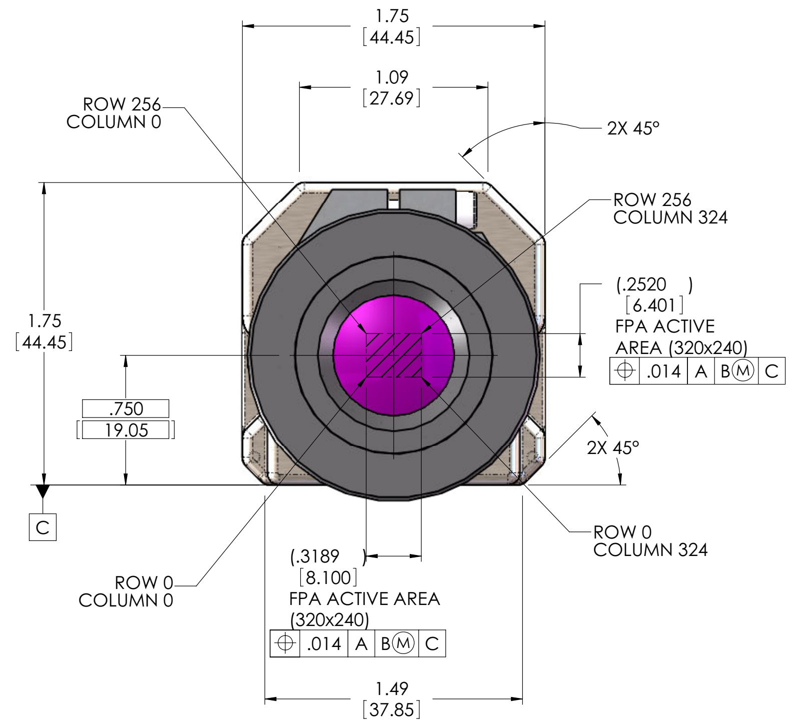
19mm-f1.1
FoV (HxV) 160x120 = 12°x10°
FoV (HxV) 320x240 = 24°x18°

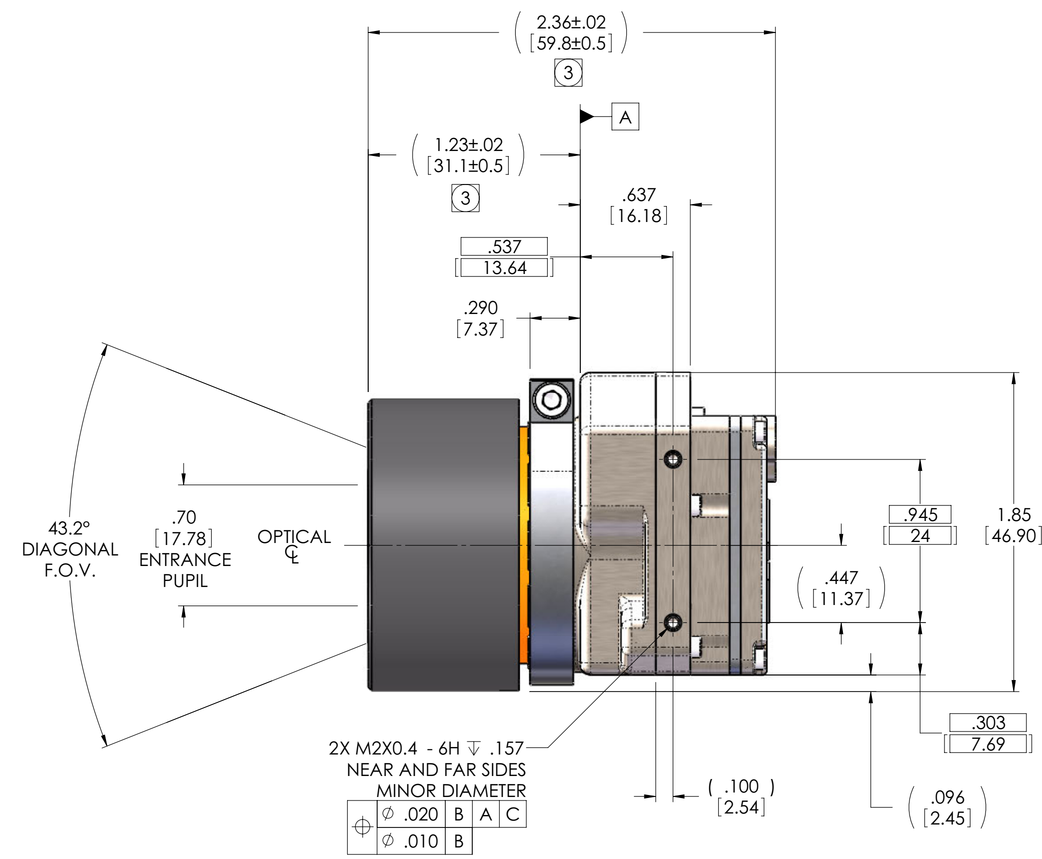
Tau Camera Core Interface Description Document 5mm - 19mm, Sheet 1

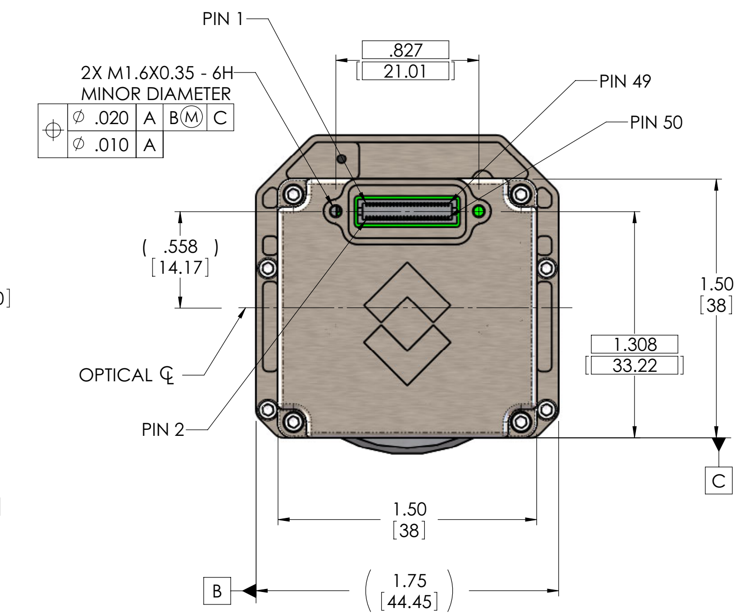
NOTES: UNLESS OTHERWISE SPECIFIED

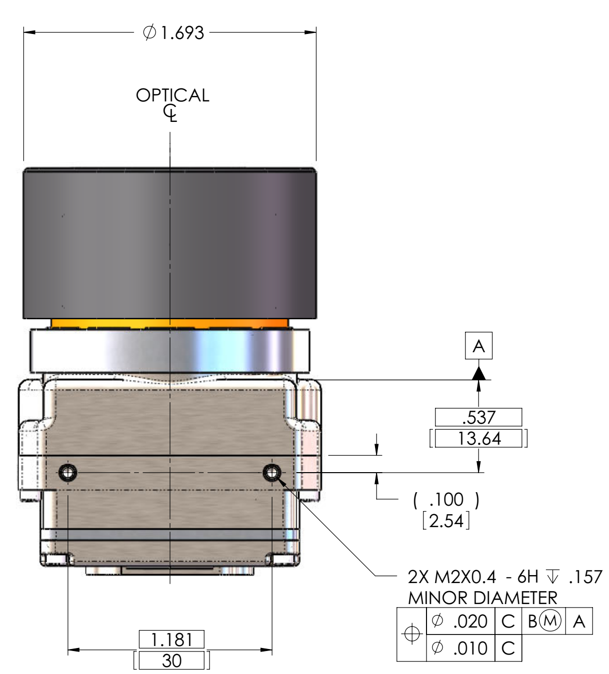
1. INDICATED DIMENSIONS ARE FOR AN ARRAY SIZE OF 320x256. POSITIONAL TOLERANCES ALSO APPLY FOR 160x120 ARRAY SIZE.
2. CONNECTOR INTERFACE: HIROSE 50 PIN DF12-50DS-0.5V(86). MATING CONNECTOR P/N DF12(5.0)-50DP-0.5V(86). FOR PIN-OUT DESIGNATIONS SEE TAU CAMERA USERS GUIDE.

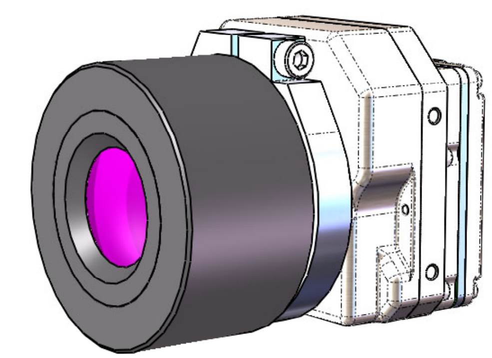
3 INDICATED ALLOWABLE TRAVEL FOR FOCUS.









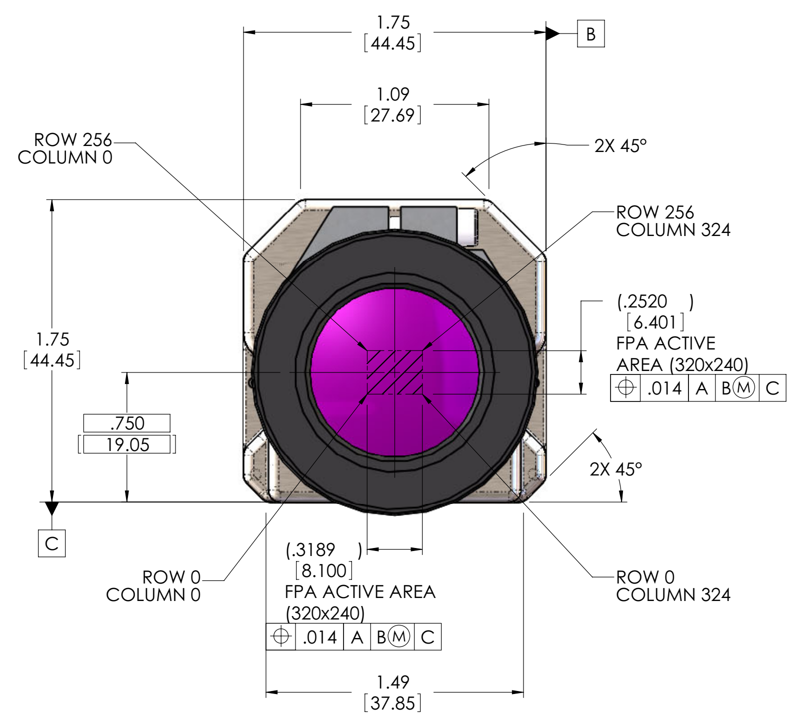


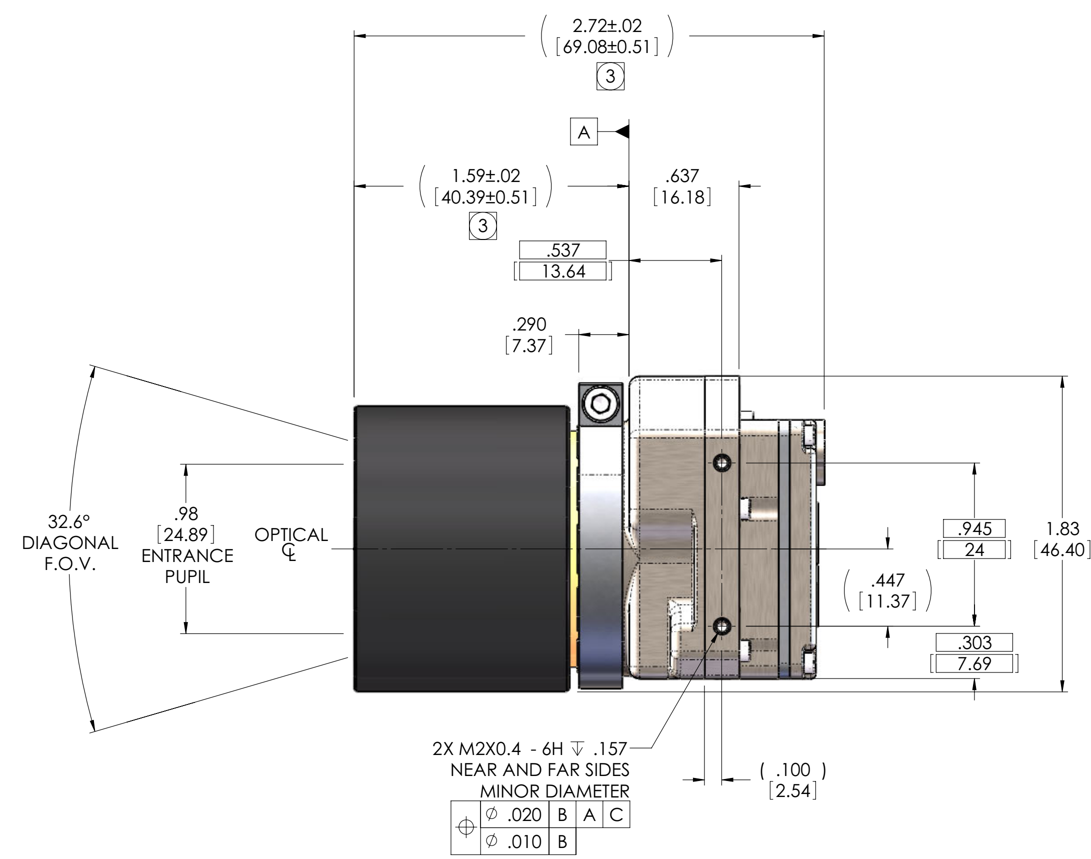
Tau Camera Core Interface Description Document 25mm Sheet 1

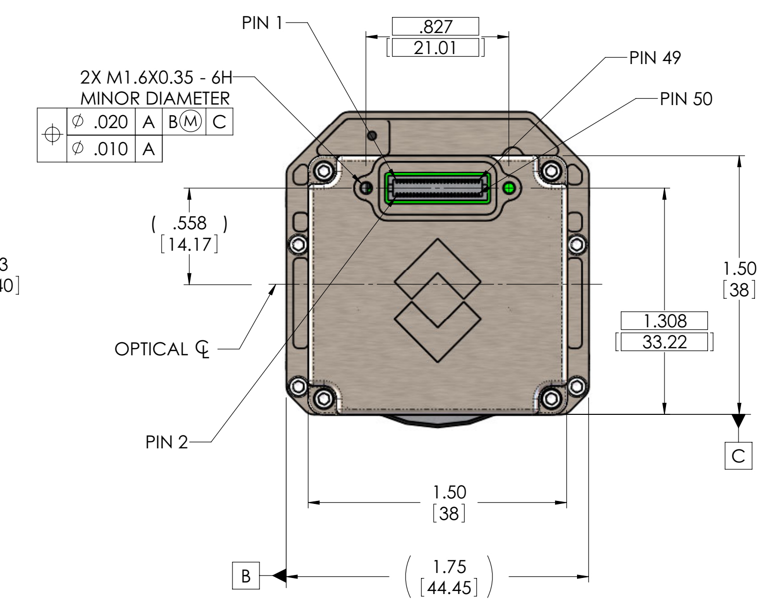
NOTES: UNLESS OTHERWISE SPECIFIED

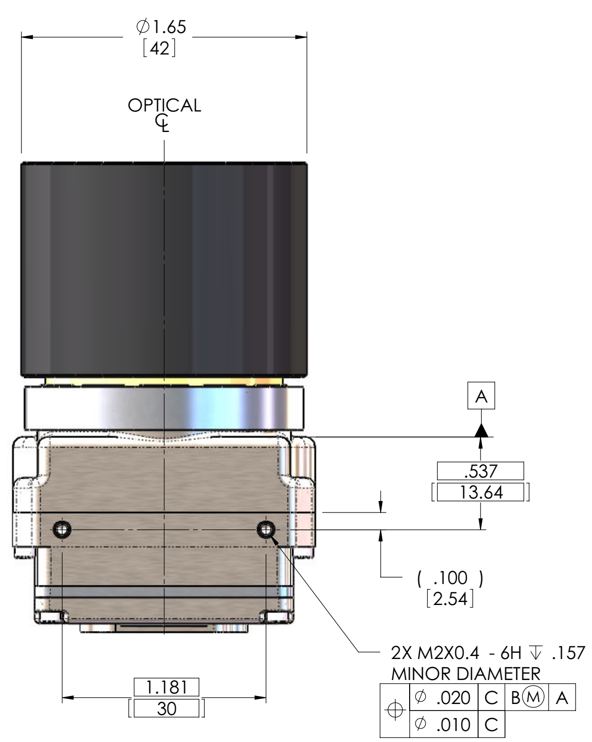
1. INDICATED DIMENSIONS ARE FOR AN ARRAY SIZE OF 320x256. POSITIONAL TOLERANCES ALSO APPLY FOR 160x120 ARRAY SIZE.
2. CONNECTOR INTERFACE: HIROSE 50 PIN DF12-50DS-0.5V(86). MATING CONNECTOR P/N DF12(5.0)-50DP-0.5V(86). FOR PIN-OUT DESIGNATIONS SEE TAU CAMERA USERS GUIDE.

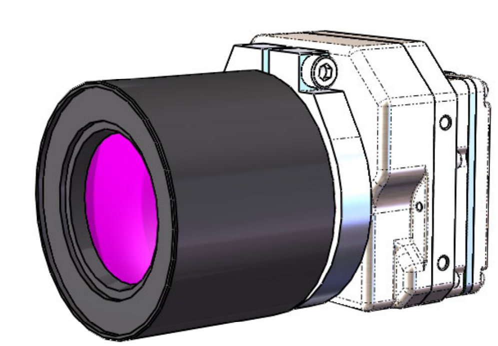
3 INDICATED ALLOWABLE TRAVEL FOR FOCUS.







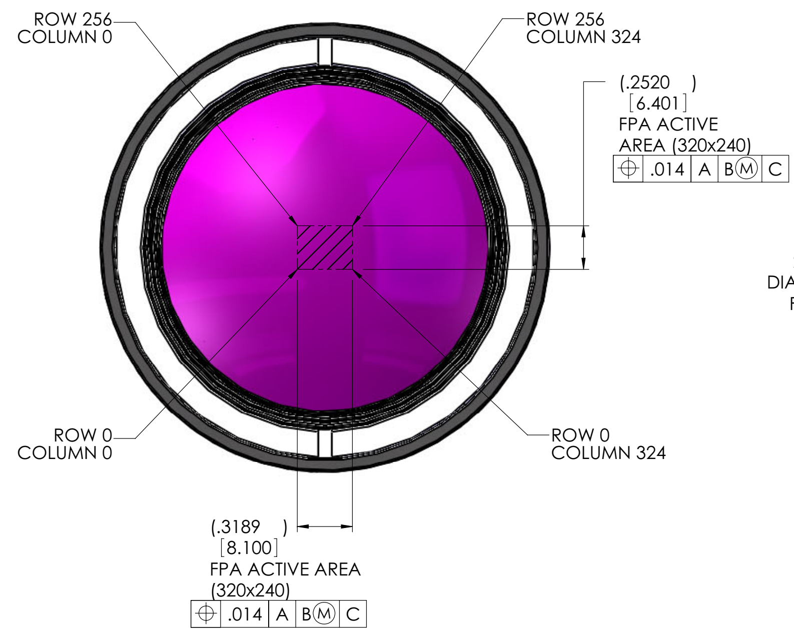


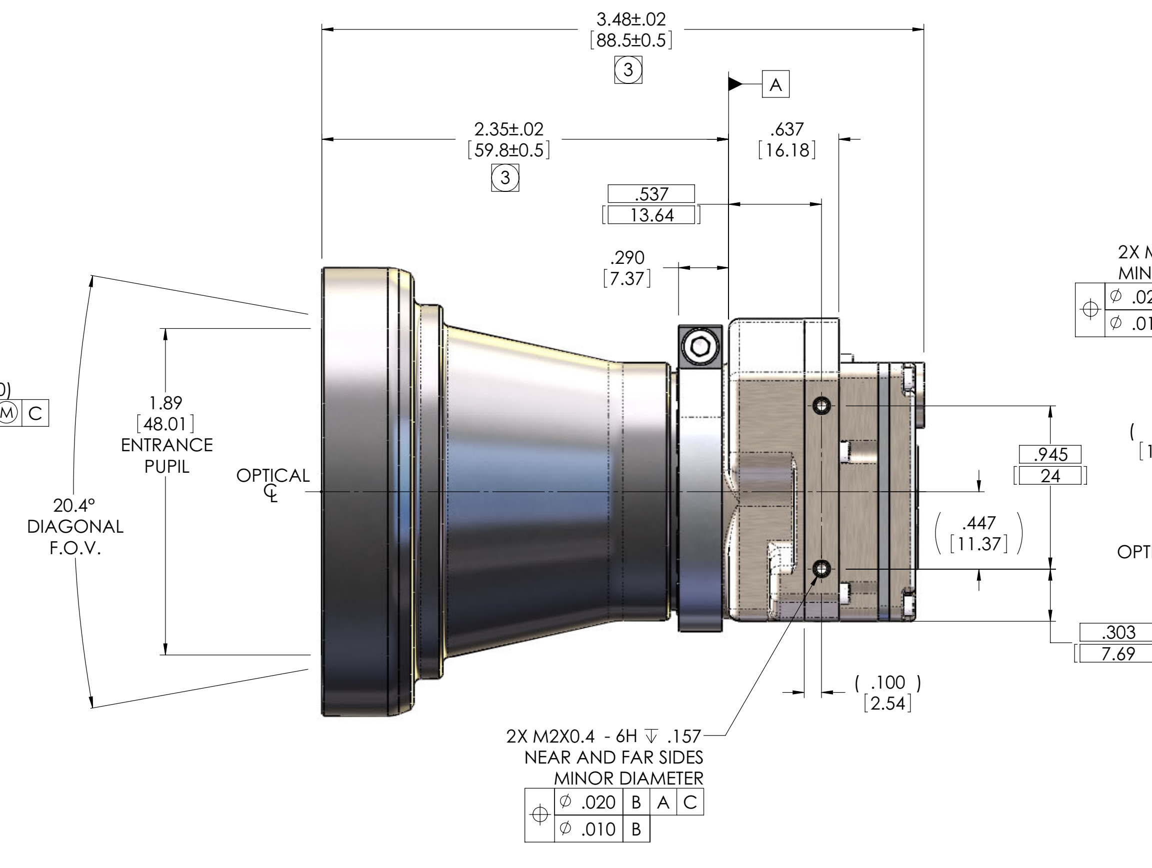


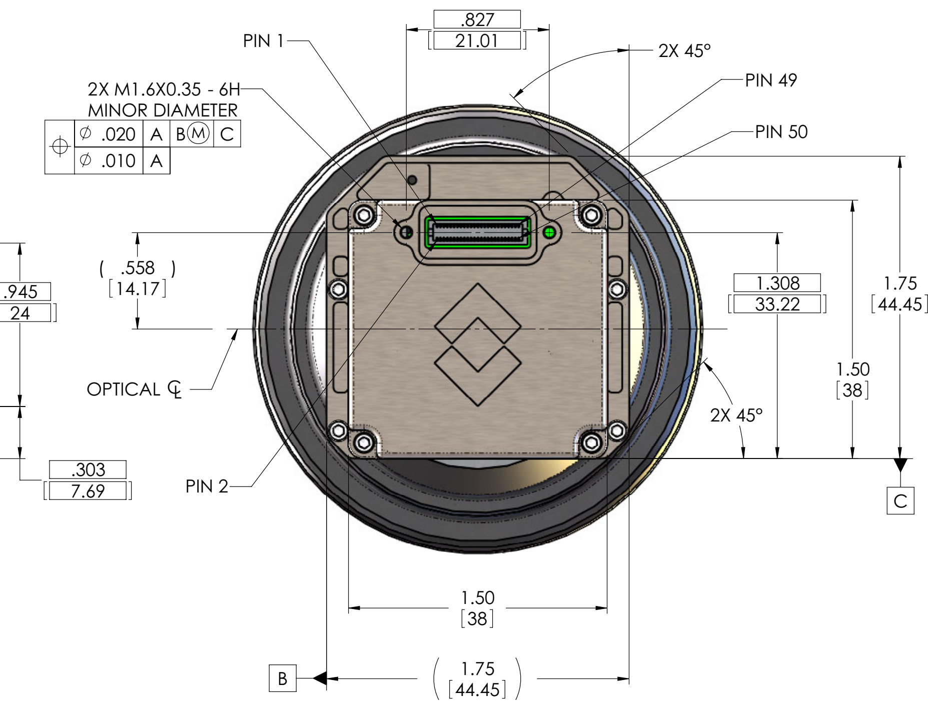
Tau Camera Core Interface Description Document 35mm Sheet 1

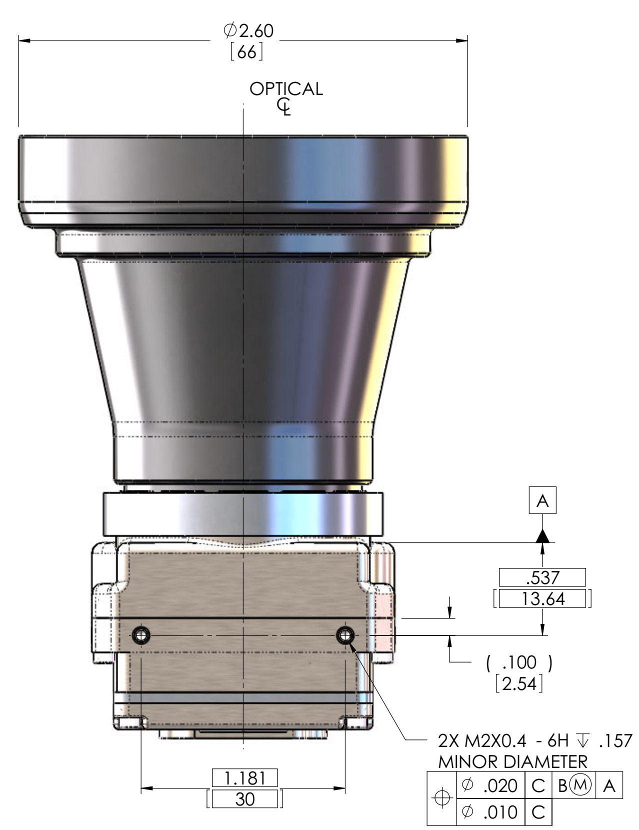
NOTES: UNLESS OTHERWISE SPECIFIED

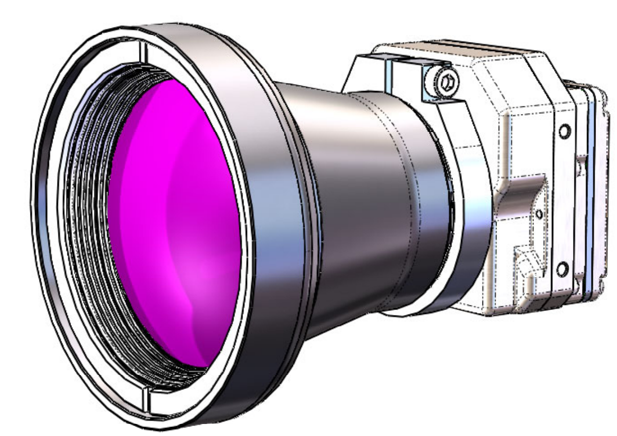
1. INDICATED DIMENSIONS ARE FOR AN ARRAY SIZE OF 320x256. POSITIONAL TOLERANCES ALSO APPLY FOR 160x120 ARRAY SIZE.
2. CONNECTOR INTERFACE: HIROSE 50 PIN DF12-50DS-0.5V(86). MATING CONNECTOR P/N DF12(5.0)-50DP-0.5V(86). FOR PIN-OUT DESIGNATIONS SEE TAU CAMERA USERS GUIDE.











Tau Camera Core Interface Description Document 60mm Sheet 1